A DIETARY INTERVENTION STRATEGY TO
FOSTER OPTIMUM GROWTH AND DEVELOPMENT
IN PRETERM INFANTS
AFTER HOSPITAL DISCHARGE

A thesis submitted to the University of Surrey for the degree of
Doctor of Philosophy
by
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March 2001
Max, at one week of age.

Max at 15 months.

This thesis is dedicated to the children, like Max, and their families who took part in this study.
SUMMARY

Preterm low birth weight infants remain at risk of impaired growth and developmental delay in childhood, compared with full-term babies.

The main aim of the research project was to devise and test a preterm infant feeding strategy (PIFS) for the time from hospital discharge until one-year gestation corrected age (GCA). The strategy recommended the early onset of weaning, the use of foods with a higher energy and protein content than standard milk formula and recommended foods, which are rich sources of iron and zinc.

To assess the effectiveness of the preterm infant feeding strategy, 68 preterm infants, mean birth weight 1.47 (SD 0.43) kg and mean gestational age 31.3 (SD 2.9) weeks, were randomised to either the PIFS group (n=37) or a current best practice control group (n=31), for one year.

Energy, protein and mineral intakes at three points, zero months GCA, six months GCA and twelve months GCA, were determined from 7-day weighed records. The infants were assessed anthropometrically at the same ages, and blood sampled twice to discover any differences in growth or nutrient status between the groups, which could be a consequence of dietary intake.

Analyses of dietary, growth and biochemical data showed the following significant differences between the PIFS intervention group compared with the control group.

- Improvements in haemoglobin and serum iron levels at six months GCA;
- Increased intakes of energy, protein and carbohydrate at six months GCA and iron at twelve months GCA;
- Enhanced length growth velocity between zero and twelve months GCA. A significant positive effect of treatment on standard deviation length scores and catch-up length growth was also observed.

PIFS significantly influenced dietary intakes with consequent beneficial effects on length growth and iron status. This novel strategy should be adopted as the basis of feeding guidelines for preterm infants after hospital discharge.
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DEFINITIONS OF TERMS AND ABBREVIATIONS

AGA  
Appropriate-for-gestational age

Baby milk  
Used in this thesis to mean any milk capable of providing a complete food for an infant from birth, such as human milk, infant formula and soya infant formula

BMF  
Breast milk fortifier

DoH  
Department of Health

EAR  
Estimated average requirement

EDD  
Expected date of delivery

ELBW  
Extremely low birth weight, an infant weighing less than 1000g at birth

ESPGAN  
European Society of Paediatric Gastroenterology and Nutrition

GCA  
Gestation corrected age, the age of a child calculated from his/her expected date of delivery

Follow-on formula  
A nutritious drink component of the diet based on cow's milk for infants over four months of age (DoH, 1994), which complies with Statutory Instrument No, 77,1995.

Infant formula  

Infant  
A child of up to one year of gestation corrected age

LBW  
Low birth weight, an infant weighing less than 2500g at birth

PER  
Protein : energy ratio, the percentage of energy derived from protein compared with the total energy available in a meal or food

Preterm  
Born before 37 weeks of gestation

PRSL  
Potential Renal Solute Load

RHCH  
Royal Hampshire County Hospital
<table>
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<th>Abbreviation</th>
<th>Definition</th>
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<td>RNI</td>
<td>Reference Nutrient Intake</td>
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<tr>
<td>RSL</td>
<td>Renal Solute Load</td>
</tr>
<tr>
<td>SCBU</td>
<td>Special Care Baby Unit/Neonatal Unit</td>
</tr>
<tr>
<td>SGA</td>
<td>Small-for-gestational age</td>
</tr>
<tr>
<td>Term</td>
<td>The time around the expected date of delivery of an infant (i.e. 38-42 weeks after conception)</td>
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<tr>
<td>VLBW</td>
<td>Very low birth weight, an infant weighing less than 1500g at birth</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Authority</td>
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</tbody>
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**Units:**

- **kg**
  Kilogram, SI unit of mass (1kg = 1000g)

- **g**
  Gram, usual unit of mass (1g = 0.001 of a kilogram)

- **mg**
  Milligram (1mg = 0.001 g)

- **μg**
  Microgram (1μg = 0.000001 g)

- **kj**
  Kilojoule, measurement of energy, equal to 1000 joules (SI unit)

- **kcal**
  Kilocalorie, measurement of energy (1 kcal = 4.18 kilojoules)

- **l**
  Litre, measurement of volume (1l = 1000 cm³)

- **dl**
  decilitre (1dl = 100cm³)
CHAPTER 1

INTRODUCTION

1.1 The Problems Associated with Preterm Birth and Low Birth Weight

1.1.i. Preterm Infants

"The term 'premature infant' only entered the English language 120 years ago. Prior to that infants who were born before term were referred to as weaklings or congenitally debilitated and were allowed to pine away and die" (Wolke, 1991).

In the scientific literature, preterm rather than premature is the preferred adjective for babies born before thirty-seven weeks of gestation. Babies who weigh less than 2500g at birth are designated as low birth weight (LBW). Preterm infants are frequently LBW; LBW infants born at term are either congenitally small or intrauterine growth retarded.

In the UK, in recent years, improvements in neonatal care have decreased the mortality rates of preterm low birth weight infants. However, these infants remain at risk of increased morbidity, impaired growth and developmental delay, compared with term babies (Cooke et al, 1998). The improved survival rates of low birth weight infants throughout the developed world have shifted the focus of concern from the risk of death to the quality of life for the survivors (The Scottish Low Birth Weight Study Group, 1992).

1.1.ii. Prevalence of Low Birth Weight (LBW)

Approximately one in fourteen babies born alive in Great Britain (7%) has a low birth weight (Wolke, 1991). Of the LBW babies born every year, 10-15% of them can be described as very low birth weight (VLBW <1.5 kg), i.e. 0.7 - 1% of all live births in Great Britain (Wolke, 1991).
1.1.iii. Survival Rates for LBW Infants and Neonatal Morbidity
Advances in neonatal treatment have ensured that up to 90% of VLBW babies and in excess of 95% of LBW infants (weighing over 1.5kg) now survive in the developed world (Wolke, 1991; Andrews, 1994).
Neonatal morbidity of LBW infants commonly results from respiratory distress, patent ductus arteriosus, necrotising enterocolitis, septicaemia and intraventricular haemorrhage (Hack et al., 1991a).

1.1.iv. Growth Problems
Compared with their normal birth weight peers, children with low birth weights grow less well during early childhood (Powls et al., 1996). Growth retardation is common in all low birth weight babies, with 26% of small-for-gestational age (SGA) and 22% of preterm infants still below the 5th percentile for height at 5 years of age (Qvigstad et al., 1993). Fewtrell et al. (2000) reported that even at eight and twelve years of age, children who were born preterm were lighter and shorter than their peers who were born at term. Disturbed bone mineralisation and bone disease (osteopenia of prematurity), with consequent growth inhibition, are also commonly diagnosed in these babies (Takada et al., 1992; Bishop et al., 1996).

1.1.v. Developmental Problems
Poor infant growth is associated with poor mental and motor skills, both of which can be a consequence of being born preterm (Carlson et al., 1993). Brain growth failure is frequently reported in the early life of preterm infants (Lucas, 1993). A meta-analysis of eighty studies measuring developmental outcomes in low birth weight infants aged from two years to ten years indicated that children born with low birth weight had significantly lower intelligent/development quotients than the children of normal birth weight (Aylward et al., 1989).

1.1.vi. Long Term Health Outlook
In addition to the health problems often encountered with prematurity, low birth weight and low body weight at one year are both associated with increased risk of chronic diseases, such as cardiovascular disease and diabetes mellitus, in later life (Lucas, 1994a, Barker, 1994).
1.1.vii. Sub Groups of Low Birth Weight Infants

Low birth weight infants do not form a wholly homogeneous group. Approximately two thirds of LBW infants have a birth weight commensurate with gestational age (Lawson, 1996); they are designated as appropriate-for-gestational-age (AGA). The remainder have a birth weight below the tenth weight percentile for gestational age and sex; they are designated as small-for-gestational-age (SGA). The distinctive subgroups, which LBW infants can be considered to fall into, are shown in Table 1.1.i.

The SGA low birth weight infants are more at risk of neurodevelopmental disadvantage than preterms (Lucas et al., 1994b), are less likely to achieve the same degree of catch up growth as preterms (Thureen & Hay, 1993), and rarely reach the same heights as term babies (Fitzhardinge & Inwood, 1989).

Some studies suggest that all groups of LBW boys are more vulnerable to neurodevelopmental problems than LBW girls (Lucas et al., 1994b; Lagerstrom et al., 1994).

### Table 1.1.i. Sub groups of LBW infants

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Description</th>
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<tbody>
<tr>
<td>Low Birth Weight (LBW)</td>
<td>Birth weight less than 2,500g</td>
</tr>
<tr>
<td>Very Low Birth Weight (VLBW)</td>
<td>Birth weight less than 1,500g</td>
</tr>
<tr>
<td>Extremely Low Birth Weight (ELBW)</td>
<td>Birth weight less than 1,000g</td>
</tr>
<tr>
<td>Premature</td>
<td>Born before the end of the full term of gestation</td>
</tr>
<tr>
<td>Preterm</td>
<td>Born before 37 weeks of gestation.</td>
</tr>
<tr>
<td>Appropriate-for-Gestational Age (AGA)</td>
<td>Length, weight, head circumference commensurate with estimated length of gestation.</td>
</tr>
<tr>
<td>Small/Light-for-Gestational Age (SGA)</td>
<td>Birth weight &lt; 10th weight percentile for gestational age &amp; sex, also known as intrauterine growth retarded.</td>
</tr>
</tbody>
</table>

1.2 Growth and Development in Preterm LBW Infants in Childhood

1.2.1. Origins of Growth and Development Deficits

The exigencies of neonatal intensive care, which often include clinical complications (1.1.iii.) and the difficulties of emulating in utero weight gain, limit growth in the neonatal period and lead to the overwhelming majority of preterm infants being growth retarded at hospital
discharge (Lucas et al., 1999; Cooke & Embleton, 2000). Thus, preterm infants begin life in the community with varying degrees of growth deficit. The extent to which they can, as a group, approach a more normal distribution on the current UK growth centiles (Freeman et al., 1995) at specific ages in childhood depends upon their ability to accelerate their growth rate and reduce or eliminate their growth deficits by those ages. Overcoming a growth deficit by any individual or group of children is known as 'catch-up growth' (Ashworth & Millward, 1986).

Perinatal growth failure is associated with poor cognitive function and poor academic achievement at eight years of age (Hack et al., 1991b).

1.2.ii. Factors Affecting Growth in Infancy

Poor growth achievement is a direct consequence of inadequate dietary intake (Cooke & Embleton, 2000). However, in the perinatal period, only 50% of growth variation in preterm infants can be attributed to dietary differences (Cooke & Embleton, 2000). Non-nutritional factors must also be assumed to contribute to poor growth.

In general, in addition to the genetically determined growth channelling (Mumford & Morgan, 1982), clinical, social and psychological factors are all acknowledged to be possible influences on infant growth (DoH, 1994). In particular, infectious states, malabsorption and endocrine disorders, congenital heart disease and psychosocial stress are all growth disrupters (Ashworth & Millward, 1986). Lower rates of head growth are associated with lower socio-economic status for VLBW infants (Ross et al., 1985) but no connection has been observed by Lucas et al. (1997) for SGA infants. The same researchers reported no link between growth and maternal smoking for SGA infants by one year of age. Genetic inheritance in the form of parental heights has been shown to significantly affect length and weight in infancy (Dewey et al., 1990) but parental stature was less useful as a predictor of appropriate growth patterns for short children (Wright & Cheetham, 1999).

It is noteworthy that several researches have indicated that, for infants, the method of delivery of nutrients affected intake and consequently growth patterns. Dewey et al. (1993) and Butte et al. (2000) identified differences in growth performance and body composition between breast-fed infants and formula-fed infants. However, the exact nature of the differences in growth, which are attributable to the mode of feeding, requires further investigation.
1.2.iii. Definition of Catch-up Growth in Preterm LBW Infants

In preterm LBW children catch-up growth can be considered to be accelerated physical development, measured by length, weight and head circumference. It allows preterm AGA and SGA infants to approach the same distribution in growth parameters as full-term AGA children. Catch-up growth may or may not include accelerated neurodevelopment. The extent of and the time scale for catch-up growth in preterm infants remain controversial.

1.2.iv. Evidence for Catch-up Growth in Preterm LBW Infants

For preterm infants, a large (n = 985) three year American study reported a degree of catch-up growth in length in the first year of gestation corrected age (GCA, age calculated from expected date of delivery) only (Casey et al., 1991). Other researchers have demonstrated differing degrees of weight and length catch up in the first year of life (Friel et al., 1985; Ernst et al., 1990; Lucas et al., 1992a; Cohen et al., 1995; Gross & Thomas, 1996) for LBW infants. A study of 500 preterm VLBW babies detected some linear catch up over the first five years of life, with a decrease in the percentage of children below the 10th percentile for height from 49% at 3 months GCA to 19% at 5 years GCA (Qvigstad et al., 1993). A brief summary of these studies is tabulated in Table 1.2.i.

**Table 1.2.i. Summary of catch-up growth studies**

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Country</th>
<th>No. of Infants</th>
<th>Gestation/ Birth Wt.</th>
<th>Study Length</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friel et al., 1985</td>
<td>Canada</td>
<td>50</td>
<td>Mean BW =1,054g</td>
<td>1 year</td>
<td>Greater length &amp; weight velocity than for term babies.</td>
</tr>
<tr>
<td>Ernst et al., 1990</td>
<td>USA</td>
<td>122</td>
<td>≤1500g ≤35 wks</td>
<td>1 year</td>
<td>Greatest catch-up growth achieved by AGA girls.</td>
</tr>
<tr>
<td>Casey et al., 1991</td>
<td>USA</td>
<td>985</td>
<td>Preterm/ &lt;2500g</td>
<td>3 years</td>
<td>Some degree of catch-up in length in first year only</td>
</tr>
<tr>
<td>Lucas et al., 1992a</td>
<td>UK</td>
<td>32</td>
<td>&lt;1850g</td>
<td>0.75 year</td>
<td>Infants fed enriched formula demonstrated enhanced growth</td>
</tr>
<tr>
<td>Qvigstad et al., 1993</td>
<td>Norway</td>
<td>565</td>
<td>≤32 wks. / ≤1,500g</td>
<td>5 years</td>
<td>Shift to standard distribution in length up to 5 years of age</td>
</tr>
<tr>
<td>Cohen et al., 1995</td>
<td>Honduras</td>
<td>28</td>
<td>&lt;2500g</td>
<td>1 year</td>
<td>Growth velocity is same for LBW &amp; term.</td>
</tr>
<tr>
<td>Gross &amp; Thomas, 1996</td>
<td>USA</td>
<td>53</td>
<td>&lt;1600g</td>
<td>0.67 year</td>
<td>Some catch-up growth had occurred by 6 months GCA</td>
</tr>
</tbody>
</table>
1.2.v. Evidence for Catch-up in Neurodevelopment for Preterm LBW Infants

Reduced growth in infancy is associated with poorer neurodevelopmental outcome in childhood (Hack et al., 1991b; Ross et al., 1985). Whether the converse, i.e. accelerated neurodevelopment associated with accelerated growth can be demonstrated, remains unclear. Several researchers, notably Alan Lucas, have shown perinatal diet can have a significant effect on neurodevelopmental performance in childhood (Lucas et al., 1994b; Williams et al., 1999). This evidence is indicative of the plasticity of brain growth and the possibility of reprogramming cognitive and psychomotor performance advantageously.

1.2.vi. Summary

The extent of catch-up growth, which is possible in the first year of life for preterm and SGA infants, remains unclear.

The achievement of catch-up physical growth, which can be measured at all ages with a reasonable degree of accuracy, may be accompanied by a concurrent neurodevelopmental improvement, though this is impossible to measure accurately in infancy.

1.3 Feeding Practices for Preterm Infants up to One Year GCA

1.3.i. Feeding Practices in Special Care Baby Units

Preterm LBW infants may not be able to feed orally immediately after birth due to prematurity and/or clinical problems. In such cases, total parenteral nutrition (TPN) or nasogastric tube feeding may be employed until oral feeding can be instigated.

The milks most usually employed for oral feeding are human milk, with or without added breast milk fortifier (BMF), a specialist formula for LBW infants, standard milk formula or a combination of these. It should be noted that preterm human milk has been shown to be more nutrient dense for a short time after delivery than mature human milk in order to supply the increased nutritional requirements of infants born prematurely (Lawson, 1996).

The macronutrient composition, together with specified mineral levels, of the milks most commonly supplied to preterm LBW infants are shown in Table 1.3.i. BMFs are usually formulated to increase the protein, carbohydrate, vitamin and mineral content of expressed human milk such that the combination of BMF with human milk more nearly approaches the estimated nutritional needs of VLBW infants (Tsang et al., 1993).
The key functions of human milk (enriched with BMF) and LBW formulas are threefold:
1. To improve the fat and glycogen stores and the vitamin and mineral status of preterm babies, all of which can be extremely low (Wilson, 1995);
2. To attempt to match in utero growth rates, estimated at 15g/kg/day (Lawson, 1996);
3. To supply extra energy and nutrients for infants with increased metabolic rates due to growth retardation (Lawson, 1996) or certain clinical conditions (Scrimshaw, 1989).

There appears to be no standardisation with regard to feeding practices in special care baby units (SCBU) or with regard to feeding recommendations after hospital discharge (Marriott et al., 1999).

1.3.ii. Milk Feeding after Hospital Discharge

Most infants are discharged from hospital when they have achieved weights ranging from 1.8 to 2.5kg (Marriott et al., 1999). The usual feeding methods at the time of hospital discharge are breast-feeding or bottle-feeding with standard milk formula. In a survey of 200 mothers of LBW babies, 78% of the babies at four weeks old were reported to be exclusively or partially breast-fed (Marriott et al, unpublished data); and by four months of age 43% of the same sample of LBW babies were receiving human milk alone or in combination with a formula milk. The remaining 57% were receiving a formula milk only. The use by mothers of post-discharge low birth weight formulas (PDLBW formula) in the UK has been found to be low (4%, Marriott et al, unpublished data). Nationally, from a survey of 5,000 babies in 1995, 44% of mothers were continuing to breast feed at six weeks of age but by four months of age only 28% of babies were receiving human milk (Foster et al., 1997).

The energy and macronutrient content of the most commonly used types of milks available for preterm infants are shown in Table 1.3.i.

Reports in the literature (Lucas et al., 1992b; Cooke et al., 1998) of standard milk formula volumes ingested by bottle-fed, preterm infants after hospital discharge and before weaning has begun, indicate that although these infants may be able to satisfy their energy needs (Tsang et al., 1993) from standard milk formula, their protein and iron requirements (Tsang et al., 1993) inter alia will not be met.

Even the growth of full-term infants in the developed world has been found to falter if breast-feeding continues beyond three months of age and this faltering may persist into the weaning period (WHO Working Group on Infant Growth, 1995).
Table 1.3.1. Compositions of milks fed to preterm infants in SCBU and after discharge

<table>
<thead>
<tr>
<th>Nutrient/100g</th>
<th>Human Milk (preterm)</th>
<th>Human Milk (Mature)</th>
<th>LBW Formula</th>
<th>PDLBW Formula</th>
<th>Standard Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>71</td>
<td>69</td>
<td>60-80</td>
<td>74</td>
<td>60-75</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>1.8</td>
<td>1.3</td>
<td>2.0-2.5</td>
<td>1.8</td>
<td>1.2-1.95</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>4.2</td>
<td>4.1</td>
<td>2.9-5.6</td>
<td>7.5</td>
<td>2.1-4.2</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>5.6</td>
<td>7.2</td>
<td>5.6-11.2</td>
<td>4.1</td>
<td>4.6-9.1</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>58</td>
<td>34</td>
<td>80-154</td>
<td>90</td>
<td>19.5</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.10</td>
<td>0.07</td>
<td>1.0-1.3</td>
<td>1.1</td>
<td>0.3-1.0</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>0.44</td>
<td>0.29</td>
<td>0.7</td>
<td>0.7</td>
<td>0.3-1.0</td>
</tr>
</tbody>
</table>

1 Lawson, 1996; 2 Tsang et al., 1993; 3 ESPGAN, 1987; 4 Cow & Gate, 1998; 5 DoH, 1994.

1.3.iii. Introduction of Solid Foods: The Weaning Process

Human milk alone will satisfy the nutritional needs of healthy full-term infants for a number of months after birth (Underwood & Hofvander, 1982). If human milk is unavailable, a baby milk specially formulated (infant formula) to meet an infant's total nutritional needs will suffice. At some point, a milk diet, whether human or formula milk, will not adequately meet the infant's nutritional and/or physiological requirements; whereupon, semi-solid foods need to be added to the infant's diet (Morgan, 1998). The gradual introduction of solid foods into an infant's diet is known as weaning or complementation (Greiner, 1996). Other terms are occasionally used to describe this process including 'transitional feeding' (Werk & Alpert, 1998) or 'sevrage' (Greiner, 1996).

In this thesis, the terms weaning and the introduction of solids, commonly used to refer to this process in the UK, will be adopted. For the purposes of this study, weaning and the weaning period are defined as:

**Weaning:**

Infant weaning is the entire process by which an infant changes from full dependence on breast milk or formula to complete independence from it (Greiner, 1996).

**The Weaning Period:**

The time during which weaning occurs, i.e. the weaning period will be considered for a preterm infant to extend from about three or four months after the date of delivery of the infant until one year gestation corrected age (GCA).

During the course of the weaning period, foods other than baby milk, in a semi-solid or solid form, will be gradually introduced into the infant’s diet.
Weaning foods are variously known as complementary foods, solids or baby foods. These baby foods may be home made or specially manufactured foods that are nutritionally and physiologically appropriate for the age of the infant (Stordy et al., 1995). Drinks other than baby milk will also be offered to the infant. Towards the end of the weaning period, an infant should be consuming a wide variety of foods with the range of textures and tastes comparable to those consumed by older children and adults in the family.

1.3.iv. Time of Commencement of Weaning:
The mean age for beginning weaning for all babies in the UK varies; 11 and 12 to 14 weeks of age have all been documented in publications (Savage et al., 1994; Mills & Tyler, 1992). These are considerably earlier than the 1994 COMA panel’s recommended age of 4 months (17 weeks), (DoH, 1994).

In general, preterm infants are introduced to solids later than term babies. A survey of 5000 families reported that more than half of all babies were introduced to solids at or before three months of age but that only 44% of LBW infants had begun weaning by this age (Foster et al., 1997). A study in the USA (Carlson et al., 1993) found the range of ages at first solid food introduction to be between 4-6.5 months GCA, whereas a study carried out in Wales reported a mean postnatal age of 14 weeks (Altigani et al., 1989).

Whether the time of starting weaning or the choice of food during weaning affects the nutritional status and growth of term AGA or preterm and SGA babies remains controversial. A study in Honduras, on normal and low birth weight babies, found no difference in growth up to 12 months of age between starting to wean at 4 or 6 months after birth (Cohen et al., 1995). An investigation involving normal birth weight infants in Scotland recorded a statistically significant increase in weight gain at one year of age for girls only, associated with early (<12 weeks of age) weaning (Savage et al., 1994). Other research has demonstrated a transitory weight advantage in term infants of both sexes introduced to solids before 12 weeks of age (Forsyth et al., 1993). Heinig et al., (1993) found that the introduction of solids increased overall energy intake for formula fed infants and that for breast-fed and formula-fed babies, the protein intake was higher at six and nine months of age in infants who received solids before six months of age, compared with infants introduced to solids after six months.

There are no official UK guidelines for weaning preterm LBW infants. Informed suggestions are based upon a consideration of the degree of prematurity, chronological age, weight and developmental status (DoH, 1994, Thomas, 1994, Blisslink/Nippers 1994). See Table 1.3.ii.
An extensive search of the published literature has failed to reveal data on the types of foods used in the weaning period of babies born preterm or SGA.

Table 1. 3.1i. UK Recommendations for weaning for LBW infants

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Age</th>
<th>Weight</th>
<th>Developmental Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>DoH (Weaning), 1994</td>
<td>None</td>
<td>≥ 5 kg.</td>
<td>Extrusion reflex lost, able to eat from spoon.</td>
</tr>
<tr>
<td>British Dietetic Association, 1994</td>
<td>16 weeks + 1/2 no. of weeks of prematurity</td>
<td>≥ 5 kg.</td>
<td>None</td>
</tr>
<tr>
<td>Blisslink/Nippers, 1994</td>
<td>around 13 weeks GCA</td>
<td>None</td>
<td>Parental perception of readiness.</td>
</tr>
</tbody>
</table>

1.3.v. Physiological Readiness for Weaning

The maturation of feeding skills is accomplished mainly by developmental changes in the central nervous system together with experiential learning in concert with anatomical development (Stevenson & Allaire, 1991). Some evidence suggests that babies are developmentally ready to chew by six to seven months of age and that to withhold solid foods beyond this age may lead to troublesome feeding problems in infancy and childhood (Illingworth & Lister, 1964).

Once enteral feeding has been established, preterm infants are subject to precocious gastrointestinal maturation. This is evidenced by the appearance of salivary amylase and increased gastric acid secretion by three months of age in full-term infants and the rise of gastric and pancreatic lipase levels in all infants after birth (King, 1998; DoH, 1994). Full-term infants as young as one month of age are capable of digesting starch rich foods such as rice, wheat, potato and tapioca in an appropriate form (Morgan, 1998).

Although some evidence links early weaning (before 15-16 weeks of age) to an increased risk of allergic diseases (Hampton, 1999) and higher rates of respiratory infection (Wilson et al., 1998), the permeability of the gut wall to large molecules decreases from birth onwards (Heyman et al., 1988). By three to four months of age only molecules less than 4 angstrom in size can pass through the gut wall (DoH, 1994). Care over the choice of weaning foods should minimise the risk of increasing rates of allergy diseases.
1.3.vi. Summary
The fact that standard formula and possibly breast milk are unlikely to meet the increased nutritional needs of preterm LBW babies for more than a very few weeks after hospital discharge argues for the early introduction of solid foods into the diet. Moreover, early weaning is commonly practised even for LBW infants in the UK without any proven serious health consequences and may have positive benefits. Heinig et al. (1993) found that babies weaned before six months of age reached developmental milestones, such as rolling over, crawling and walking, significantly earlier than babies who began weaning after six months of age. In addition, there was no difference in prevalence or incidence rates of illness between the two groups.

Enteral feeding appears to prime the digestive system regardless of gestational age at birth. Allergenic disease risks can be minimised if due attention is given to the age of solid food introduction and food types.

1.4 Impact of Nutrition on Growth and Development with Special Reference to Catch-up Growth
That adequate nutrition is necessary to engender physical growth in all infants is incontrovertible (Qvigstad et al., 1993). The extent to which nutrition in early infancy affects subsequent neurodevelopment in all children is contentious (Grantham-McGregor et al., 1991). However the work of Lucas (Lucas et al., 1994b, Lucas et al., 1990) would seem to have convincingly demonstrated that the composition of the postpartum milk diet, when given for only 4 to 5 weeks, can affect later mental and motor functioning significantly in low birth weight babies.

The advantages of feeding LBW babies with special preterm formulas, with higher levels of energy, protein, minerals and vitamins than standard formula, or with human milk fortified with a protein and mineral supplement for the first few weeks of life are generally accepted (Lucas et al., 1994b; Hayashi et al., 1994). The possible benefits of longer term nutritional support are less well documented. One study reported a marked improvement in growth velocity from feeding preterm babies an enriched formula up to 9 months of GCA (Lucas et al., 1992a). Other research supports the growth enhancing benefit of specific nutrients, such as zinc (Friel et al., 1985; Altigani et al., 1989; Prentice & Bates, 1994), long chain fatty acids
(Lucas et al., 1994b; Uauy-Dagach et al., 1994), calcium (Lapillonne et al., 1994; Bishop et al., 1996), and selenium (Friel et al., 1993).

In a comparative trial, accelerated increases in length, weight and head circumference, believed to be a consequence of higher protein intakes, have been achieved for boys by feeding a nutrient enriched versus a standard formula for 6 months after the expected delivery date (Cooke et al., 1996).

The published results cited above all support the hypothesis that specific nutritional management is necessary, for considerably longer than for a few weeks postpartum, to promote optimal growth and development in preterm and SGA babies. This implies that an evaluation of the nutritional requirements of these infants, for the period after hospital discharge and throughout the first year of life at least, is essential to ensure that preterm LBW infants are fed appropriately and achieve their growth and development targets.

1.5 Requirements for Specific Nutrients for Preterm Infants in the Weaning Period

1.5.i. Macronutrients

There is little, if any, information concerning energy needs or the reference nutrient intake of each macronutrient for LBW infants throughout the weaning period, other than those provided for "stable/growing preterm infants" in the neonatal period (Tsang et al., 1993, p288-9) and those for term babies (DoH, 1991). See Appendix I.

1.5.ii. Energy

Tsang et al. (1993) recommended an energy intake of 110-120 kcal/kg/day up to 6 months of chronological age for all LBW infants. SGA infants may have an even higher average energy requirement due to a higher energy expenditure than other LBW babies, in the neonatal period at least (Cauderey et al., 1988).

For the full term infant, the estimated average requirement (EAR) for energy is 100kcal/kg/day at 3 months reducing to 95 kcal/kg/day at 6 months of age, (DoH, 1994). The 1992 MAFF survey recorded a median intake of energy for infants between 6-12 months old
of 842 kcal/day, which may exceed the needs of some of this age group of full term infants, (Mills & Tyler, 1992).

There are indications that LBW infants may have different nutritional requirements to those of term babies. For example, Friel et al., (1985) found that energy and protein intakes were greater for preterm compared to term infants from 3-12 months GCA.

Reports of data, derived from nutritional intake studies of free-living infants, show that the percentage of energy derived from fat decreases from around 50% in the first 4 months of life, when milk is the predominant food, to 35-40% by 8 months of age (DoH, 1994). Hence, the energy density of the food in the diet may decrease with age, which could affect catch-up growth in LBW babies.

There is some concern about the energy density of weaning foods, especially in the initial stages, since home prepared solid foods often have a lower energy content than breast milk (Stordy et al., 1995). The poorer absorption of fructose, frequently present in commonly used weaning foods at relatively high levels compared to other sugars, could also be a factor in reducing energy intake (Stordy et al., 1995). There is no specific data available with respect to the energy content of weaning foods used to feed LBW babies.

1.5.iii. Protein

There are no published guidelines for protein intake other than those adopted by the manufacturers of post discharge LBW formulas, 2.7-3.6g of protein/kg of body weight/day and the Tsang et al. (1993) recommendations of 3.0-3.8g/kg of body weight/day for the neonatal period.

One group of preterm infants fed a high protein formula, has been reported to increase protein intake and growth velocity compared to another group consuming standard formula (Cooke et al., 1996). There are also indications that SGA babies, in the neonatal period at least, may be able to tolerate higher protein intakes than those presently recommended and may have a higher requirement for protein than their AGA counterparts (Micheli & Schutz, 1993).

Full term infants have a reference nutrient intake (RNI) for protein of 12.7g/day from 4-6 months of age (DoH, 1994). The 1992 MAFF survey reported a median intake of 30.4g of protein at 6 months of age, which clearly exceeds the needs of this age group of term infants (Mills & Tyler, 1992).
1.5. iv. Fatty Acids
The fatty acid composition of the diet appears to be more crucial for preterm than for term infants. The ability to secrete enzymes required to synthesise the long chain polyunsaturated fatty acids (LCPUFA), arachidonic and docosahexaenoic acids (necessary for neural development and visual cortical function) from the essential fatty acids (EFA), linoleic and linolenic acids, matures during the first half of infancy (DoH, 1994). Hence preterm infants are believed to require, not only the correct amount and balance of EFAs, but almost certainly these LCPUFAs for several months postnatally (DoH, 1994; Uauy-Dagach et al., 1994). An Italian study found that dietary intakes of linoleic and linolenic acids were at the lower limits of recommended levels in preterm babies during weaning (Giovannini et al., 1992). Thus, at this time, production of arachidonic acid and docosahexaenoic acid could be reduced from lack of substrate, as well as enzyme immaturity and subsequent growth and neurodevelopment could be prejudiced. (Carlson et al., 1993; DoH, 1994).

1.5.v. Micronutrients
In general, for micronutrients as for macronutrients, recommendations for LBW babies after term are presumed to be the same as for term AGA babies. For a few nutrients, particularly those associated with growth, the specific requirements of LBW infants have been investigated.
No specific differences have been demonstrated in research studies for SGA versus AGA infants in zinc, iron or selenium status. Nor has a gender difference in iron status been demonstrated. SGA and male infants have not been shown to be more or less disadvantaged in bone density compared to their AGA and female counterparts (Bishop et al., 1996).

1.5.vi. Zinc
The importance of zinc status for growth has been acknowledged (DoH, 1994). Sufficient dietary zinc is particularly crucial for preterm babies for a number of reasons. They are born with low zinc stores (Friel et al., 1985), breast milk and formula may provide insufficient utilisable zinc for VLBW and even LBW infants (Friel et al., 1985) and perinatal folate supplementation decreases zinc absorption (Fuller et al., 1992). Additionally, weaning may decrease the efficiency of absorption of zinc (DoH, 1994) and home prepared weaning foods often have a lower content of zinc than their commercial counterparts (Stordy et al., 1995).
Some research indicates that over one third of LBW infants may be zinc deficient at six months of age (Reifen & Zlotkin, 1993), probably because foods, such as meat, with high zinc content are not commonly included in weaning foods in appropriate amounts.

The mean zinc intake of all babies aged 6-12 months has been shown to reach only 90% of the RNI (4-5mg/day) for this age group, (Mills & Tyler, 1992). The recommended daily requirement for stable/growing preterm infants for 6 months after birth has been set at 1mg/kg/day (Reifen & Zlotkin, 1993), which is higher than the RNI for most term babies of a similar gestational age.

In one study, male preterm infants were shown to have lower plasma zinc concentrations, at the same dietary intake levels, than their female counterparts (Altigani et al., 1989).

### 1.5.vii. Iron

The iron intake and absorption of iron in LBW infants is important because 8-13% of all UK children, aged between 1½ to 4 years, are believed to be iron deficient (Gregory et al., 1995). Preterm are at particular risk of deficiency because they have low initial iron stores at birth, which become further depleted as growth occurs (DoH, 1994). It has been demonstrated in Costa Rican children that iron deficiency anaemia at 1-2 years of age, even when corrected, leads to impaired mental and motor skills at 5 years of age (Lozoff et al., 1991). Weaning may decrease the efficiency of absorption of iron (DoH, 1994) and foods high in iron, such as meat, are less frequently consumed at this stage of life. Additionally, home prepared weaning foods may have a lower iron content than commercial preparations (Stordy et al., 1995). The MAFF survey (Mills & Tyler, 1992) found the median iron intake of full-term babies at 6-12 months old to be below the RNI (4.3-7.8mg/day).

The recommendation for stable/growing preterm infants is 2mg/kg of body weight up to a maximum of 15mg/day until one year of age (Ehrenkranz, 1993).

### 1.5.viii. Calcium

Calcium status is of particular concern for preterm infants throughout infancy due to the prevalence of bone disease in these babies (Bishop et al., 1996) and the correlation between bone mineral content and linear growth (Lucas et al., 1992a; Schanler & Rifka, 1994). Preterm babies are born with and maintain low stores of bone forming minerals for at least one month postnatally (Takada et al., 1992). If breast fed, their body stores of calcium may remain depleted because the calcium content of human milk is relatively low (Takada et al.,
1992), although breast feeding appears to be correlated with increased bone mineral content in later childhood (Bishop et al., 1996). However, some catch-up in bone mineral content has been noted around 8-16 weeks post term (Bishop et al., 1996), which may coincide with the beginning of weaning. Preterm infants fed an enriched post discharge formula up to 9 months GCA had increased growth and bone mineral content compared to those fed a standard formula (Bishop et al., 1993). The Koo & Tsang (1993) recommendation for stable/growing preterm infants is 120-230mg of calcium /kg of body weight. No information about the vitamin D status of preterm infants, and its interaction with calcium after the neonatal period, has been found.

1.5.ix. Selenium

Plasma selenium concentrations are acknowledged to be lower in preterm infants, for the first few months of life, compared to term infants, (Daniels et al, 1997; Smith et al., 1991). Nevertheless, the clinical symptoms of overt selenium deficiency have not been reported in LBW infants (Wharton, 1987). However, the selenium-dependent glutathione peroxidase activity of red blood cells has been shown to decrease in VLBW infants fed <10μg/day selenium during the first six months of life, which is suggestive of an inadequate intake (Friel et al., 1993) and the plasma and erythrocyte selenium levels of formula fed preterm infants have been shown to decrease throughout the first six weeks of life (Daniels et al, 1997). Recommendations for selenium intakes in the weaning period for LBW infants include the supplementation of preterm formulas with selenium to produce 2-2.5μg/100ml (Friel et al., 1993) and the recommendations for stable growing preterm infants of 1.3-3.0μg/kg of body weight/day (Tsang et al., 1993).

Two measures of selenium status, se-dependent GPx activity and erythrocyte selenium, have been found to be higher in female compared with male preterm infants in the first year of life (Friel et al., 1993; Daniels et al, 2000).

1.5.x. Nutrient Interactions

For adults and children, the absorption and utilisation of any nutrient in the diet may be enhanced or reduced by the presence of other food constituents. Of particular importance in the weaning diet are:

- An adequate supply of food energy for optimal protein accretion (Swyer, 1995);
- A sufficient dietary protein and zinc intake to allow efficient utilisation of vitamin A, (Hunt & Groff, 1990);
- The maintenance of the correct balance of essential fatty acids, linoleic: linolenic acids to ensure that LCPUFA formation is not reduced by excess linoleic acid intake (>12% total energy), or that arachidonic acid (AA) production is not hindered by excess docosahexaenoic acid (DHA) and eicosapentaenoic acid production (Uauy-Dagach et al., 1994);
- The correct balance of AA to DHA in formula/food intake to prevent the inhibition of the linoleic acid to arachidonic acid pathway (Uauy-Dagach et al., 1994).

In addition, the relationships between the mineral components of the diet with each other, mainly through common absorption pathways and with other nutrients should be given serious consideration. In particular:

- Calcium absorption and metabolism are affected by vitamin D status and by the levels of phosphorus, sodium, magnesium, protein, non starch polysaccharide and unabsorbed fat in the diet (Hunt & Groff, 1990);
- Iron absorption depends upon the form of the mineral (heme or non heme, ionisation state, Fe^{2+} or Fe^{3+}) and the concomitant ingestion of either absorption enhancers, such as ascorbic, citric and lactic acids and meat, or absorption inhibitors, such as phytates, phosvitin and calcium phosphate (Hunt & Groff, 1990);
- Zinc absorption may be adversely affected by high intakes of iron, copper, calcium or phytates (Hunt & Groff, 1990).

1.5.xi. The Nutritional Requirements for Catch-up Growth

For growth to occur all the individual components for tissue deposition must be available in appropriate amounts. Hence, the rate at which growth takes place will be curtailed if one or more nutrients are only available in limited amounts (Jackson & Wootton, 1989). Evidence from previous studies suggests that dietary protein and/or zinc may be the limiting nutrients for growth in children once energy requirements have been satisfied (Ashworth & Millward, 1986; Millward, 1995; Cooke et al., 1998).

To sustain high rates of lean tissue deposition i.e. catch-up growth, requires a high protein : energy ratio (Jackson & Wootton, 1989). The protein and energy intakes required to promote catch-up growth have been estimated factorially and determined in vivo. For catch-up growth, recommendations for protein : energy ratio (PER) include 11% (Jackson & Wootton, 1989),
11% (Ashworth & Millward, 1986), 10.8% at 75% protein utilisation efficiency (Wharton 1994), and 11.4% (Cooke et al., 1998). These percentage ratios of protein energy to total energy considerably exceed those available from human or standard formula milk.

1.5.xii. Summary

The specific nutrient requirements for preterm LBW infants after hospital discharge and throughout weaning need further clarification. Catch-up growth can only occur if sufficient energy together with appropriate quantities of all other nutrients are provided in the diet. For preterm infants, a diet consisting of human milk and/or standard milk formula alone is unlikely to provide the levels of several nutrients in general and protein in particular, which are required for catch-up growth.

The timing and extent of catch-up growth, which can be achieved in the first year of life by preterm and SGA infants, and the degree of impact which nutrition in infancy can have on future growth and neurodevelopment remain controversial.

1.6 Methods of Dietary Assessment

Determination of energy and nutrient intake is difficult to measure accurately and reliably for individuals in the community. The Manual of Dietetic Practice (Thomas, 1994) recommends weighed dietary records as the most accurate method of dietary assessment. In general, a seven day weighed record should afford a determination of energy, protein and carbohydrate intake to within 10% of the true value for adults; longer records may be necessary to achieve the same degree of accuracy for fat, mineral and vitamin intakes (Bingham, 1987). However, individuals with stable food intakes should have lower individual coefficients of variation than the population at large, which may justify shorter recording periods without loss of accuracy (Thomas, 1994). A high correlation has been reported between three and seven-day weighed intakes for infants, which suggests that infants have stable food intakes (Mumford & Morgan, 1982).

In healthy individuals, if practical, twenty-four hour urinary nitrogen output as a measure of protein intakes or doubly labelled water estimates of energy expenditure can be used for validity and bias checks on the dietary record results (Bingham, 1987). Ideally, individual energy intake results should be examined and compared with average basal metabolic rate
energy expenditure for the age group under observation to exclude under and over estimates (Bingham, 1987).

1.7 Biochemical Analyses

In healthy individuals, an examination of body fluids, tissue samples or body waste products and exudates can be used to determine the level of one or more physiological chemicals derived from essential nutrients. This procedure will provide an estimation of nutrient status when compared with known standards. Blood samples can be assayed to provide information about the body content of essential minerals, protein metabolism or the presence of malnutrition inter alia.

Iron:
Many and varied are the possibilities for assessing iron nutriture. Severe iron deficiency, which is manifested as iron deficiency anaemia, can be determined from the blood haemoglobin level and the haematocrit (% packed cell volume), (Hunt & Groff, 1990). Mild iron deficiency requires the evaluation of body iron stores, primarily by measurement of the serum ferritin level and transferrin saturation (Hunt & Groff, 1990). Serum iron levels and red blood cell protoporphyrin levels can also be assayed (Hunt & Groff, 1990; Clayton & Round, 1994).

Zinc:
The strong homeostatic control of body zinc level makes determination of zinc status very difficult (Hunt & Groff, 1990). However despite the drawbacks, the measurement of serum or plasma zinc is the analysis of first choice (Taylor, 1996).
Special precautions in the sampling technique for zinc are needed to reduce zinc contamination from glass and metal apparatus, and anaesthetic creams (personal communication from H.T. Delves, trace element specialist).

Selenium:
Selenium can be analysed from blood plasma or serum, which reflect recent selenium intake (Taylor, 1996), from whole blood or erythrocytes, which reflect longer term status (Clayton & Round, 1994) or from a functional measure by determination of glutathione peroxidase (Taylor, 1996).
**Copper:**
Assessment of copper status can be determined from plasma or serum copper concentration or by determination of blood caeruloplasmin concentration (Taylor, 1996).

**Manganese:**
Manganese levels are better determined from whole blood rather than serum, where concentrations are likely to be close to detection limits (Taylor, 1996).

**Transferrin:**
Transferrin is the transport molecule for ferric iron. It is produced when apotransferrin (a β-globulin formed in the liver) complexes with iron (Hunt & Groff, 1990). Transferrin levels can be assayed from blood plasma and provide a measure of malnutrition or iron-deficiency anaemia. Low concentrations of transferrin are indicative of malnutrition whereas high levels may indicate iron-deficiency anaemia (Clayton & Round, 1994).

**Urea:**
Urea is the end-product of protein decomposition. Urea levels reflect protein quality in the diet and the effectiveness of protein utilisation (Clayton & Round, 1994; Jackson & Wootton, 1989).

Blood plasma or serum is used in urea determination.

### 1.8 Anthropometric Determinations

#### 1.8.i. Growth References

In general, infant growth measurements serve several purposes. They are primarily an outcome measure of nutritional status and, in the absence of clinical pathology, an indicator of health status and overall development.

The growth of an individual infant can only be reliably assessed in comparison with an appropriate reference i.e. a set of growth data from a large, well nourished, cross-sectional population (Waterlow et al., 1977).

The current UK growth standards are the 1990 Growth Reference Centiles (Freeman et al., 1995), based upon the growth patterns of 37,700 children ranging in age from 23 weeks of post-conception age up to 23 years of chronological age (Cole et al., 1998).
The 1990 reference centiles are representative of the growth patterns of all British, Caucasian children, including those born prematurely (Cole et al., 1998) and are an appropriate standard for assessing the growth patterns of preterm infants in the UK.

1.8.ii. Growth Measurements
The three most commonly used measurements of growth for infants are body weight, supine length and occipitofrontal head circumference. Other measurements can be made, including mid arm circumference, chest circumference, knee to heel length and skinfold thicknesses at specified points, such as triceps and subscapular skinfolds.

The accuracy of a set of weight, length or head circumference determinations will be greater if the same person performs all the measurements using identical procedures because intra-operator variation is smaller than inter-operator variation (Roche et al., 1989).
Measurement bias can be reduced or eliminated if the observer has no access to previous readings or to the child's growth chart (Hall, 1996).

1.8.iii. Methods of Comparison to the Reference
The most frequently employed anthropometric indices are weight-for-age, height-for-age and weight-for-height (Gorstein et al., 1994). Weight-for-age measurements, which are effectively a composite index of height-for-age and weight-for-height, do not distinguish between wasting and stunting (Gorstein et al., 1994).

There are various commonly used methods and scales for comparing an individual child or group of children's growth performance with a reference.

Percent of the median:
A comparison of a particular measurement with the mean/median value for children in the reference population will yield a percentage value which indicates how close that measurement is to the reference mean/median value for a child of the same gender at that age.

\[
\text{% of the Median} = \frac{\text{Actual Measurement}}{\text{Median Measurement}} \times 100
\]

This method assumes a normal distribution for the index of growth in question, which is not a valid assumption for weight distribution. Furthermore, the range of variability with age differs, which makes it difficult to assess growth performance over time or between children of differing ages (Frisancho, 1993).
**Body Mass index:**

For children whose weight and recumbent length/height are known, the body mass index can be computed (Thomas, 1994).

\[
\text{BMI} = \frac{\text{Weight}}{(\text{Height})^2}
\]

BMI charts for infants and children have not been in common usage (Hall, 1996) but are now available (Cole *et al.*, 1998).

**Percentile Position:**

Percentile lines are normalised curves from which a child's centile position for each growth measurement can be determined. In the 1990 Growth Reference Centiles (Freeman *et al.*, 1995), each marked percentile line is 0.67 standard deviations from its neighbours. Thus, the 2\textsuperscript{nd} and 98\textsuperscript{th} centile lines mark the growth trajectories of individuals whose measurement values are two standard deviations away from the median/mean value of the growth reference. However, centile positions, because of their limited numbers, are less useful for describing the extreme ends of the distribution than standard deviation scores (Gorstein *et al.*, 1994).

**Standard Deviation Scores:**

Standard Deviation Scores (SDS) are also known as Z-scores.

\[
\text{SDS} = \frac{\text{Subject's Value} - \text{Standard's Mean Value}}{\text{Standard Deviation of the Standard}}
\]

This method of growth assessment can be applied to normally and non-normally distributed data and the same cut-off point can be applied at all ages to distinguish the extremes of growth (Frisancho, 1993). For these reasons and the elimination of gender differences in this method, the transformation of growth measurements into SDS appears to be the method of choice for the majority of workers in the field of child health and assessment of nutritional status, at this time.
1.9 The Research Problem

There are no cohesive, evidence-based recommendations for feeding preterm LBW infants after hospital discharge in the UK.

Growth outcomes of infants born either preterm and/or small-for-gestational age suggest that the nutritional needs of these infants are not being met by the current practice of treating low birth weight (LBW) infants as term, appropriate-for-gestation infants after hospital discharge (Section 1.1). Preterm LBW infants have increased nutritional requirements (Section 1.5) and decreased intestinal capacity compared with their AGA term peers. The need for specific nutritional management for all LBW babies, after discharge from hospital, is increasingly being recognised although there appears to be very little information available about the ideal regimen.

Recommendations for the nutritional management of preterm low birth weight infants (<2.5 kg birth weight) after hospital discharge must accommodate the following elements:

1. The increased nutritional needs of preterm infants (section 1.5.i. - ix.).
2. The energy and protein requirements to permit catch-up growth (section 1.5.xi.).
3. The unsuitability of standard formula alone or possibly human milk alone to meet the nutritional requirements of preterm infants for more than a few weeks after hospital discharge (section 1.3.ii.).
4. Solid foods introduced into the preterm infant's diet must have a nutrient density greater than that of standard milk formula to prevent growth faltering.
5. The increased provision of those micronutrients in the diet particularly associated with growth and development (zinc, iron, calcium and selenium).
6. A sufficient intake and balance of long chain polyunsaturated fatty acids.

To investigate this surprisingly neglected area of infant nutrition a "preterm infant feeding hypothesis" has been devised. A comprehensive literature survey, consideration of the accepted nutritional requirements of preterm infants, the nutritional requirements for catch-up growth and consultations with experts in the field of infant nutrition have been amalgamated to produce the hypothesis.
1.10 The Hypothesis

The preterm infant feeding hypothesis states that the optimum growth and commensurate development of preterm infants, i.e. the achievement of catch-up growth outcomes measured by weight, length and head circumference by twelve months GCA, require:
1. The early introduction of solid foods to the infant diet.
2. That the solid foods used throughout weaning should have an energy density greater than that of breast milk and standard baby milk formula to provide sufficient energy for growth.
3. Wherever possible, that the solid foods used throughout weaning should have a protein content above that of breast milk or formula to ensure that sufficient protein is available for growth.
4. That the choice of foods offered to the infant should optimise the intakes of iron, zinc, calcium, selenium and long chain polyunsaturated fatty acids.

1.11 The Aim of the Study

To devise a strategy for the nutritional management of preterm/low birth weight infants from hospital discharge until one-year post term.

The study will seek to demonstrate that the preterm infant feeding regimen, proposed in 1.10, will promote growth velocity and thus improve catch-up growth and development in preterm infants to a greater extent than the current, commonly advised feeding practices, which are based on the recommendations for term infants.

1.12 The Study Objectives

1. To devise a set of recommendations for feeding preterm infants from hospital discharge until one year GCA which address the following issues:
   - the optimum age and/or weight of an infant at the introduction of solid foods,
the desirable range of intakes /kg of body weight for energy, and /100 kcal for protein, zinc, iron and selenium,
the appropriate range of energy densities for weaning foods,
the order of introduction of different types of solid foods.

2. To produce a practical feeding guide for parents.

3. To compare the effects on dietary intake, biochemical status and growth in two groups of preterm infants in a randomised, comparative, intervention trial. One group of infants will follow the advice on weaning in the “the preterm infant feeding recommendations”; the other group will follow current best practice for weaning full-term infants.
CHAPTER 2

SUBJECTS AND METHODS

2.1 The Strategy to Test "The Preterm Infant Feeding Hypothesis"

The best infant feeding practices in relation to physical growth and neurological development were incorporated into a feeding strategy which conformed to the requirements of the study hypothesis (Section 1.10). The vexed question of the earliest appropriate age/weight-stage at which the introduction of solid foods could begin was resolved after consideration of a survey of published common practices (Foster et al, 1997), discussions with paediatricians and dietitians, and advice from the study supervisors.

The strategy proposed that:

1. Preterm infants would be introduced to semi-solid foods from around 13 weeks of postnatal age, provided the infant weighed at least 3.5 kg, the parents detected signs of weaning readiness and that the baby was past his/her expected date of delivery.

2. The energy density of suitable baby foods, whether home prepared or commercial foods, would be in the range 300-450 kJ/100g, (70-105 kcal/100g).

3. The protein content of suitable baby foods would be in the range of 2.3-5.0 g/100g for cereal and savoury foods, and 1.0-4.0 g/100g for fruit puddings and other desserts.

4. The major contributory solid foods to the infant diet would be cereals, potatoes and other starch rich, low fibre vegetables and pulses, meat, fish and a limited quantity of cheese. This would ensure an improved intake of essential minerals, which are important for growth, i.e. iron, zinc and selenium.

5. Where feasible baby milk, either Nutriprem (a special formula for LBW infants) or after eight months of age a follow-on formula (baby milk specially formulated for older babies), would be used as the liquefying agent for dried cereal foods and home prepared
dishes. This would increase the energy and nutrient density of the food, particularly the protein, calcium, iron and zinc content of the meal. In addition, the level of long chain polyunsaturated fatty acids in the diet would be enhanced.

6. Weaning foods (home prepared and/or commercial baby foods), which complied with the energy and protein densities outlined above, would be introduced in the following order:
   - Baby rice + Nutriprem milk and/or alternative cereal/Nutriprem milk mixes;
   - Potato with/without other vegetable purées with Nutriprem milk and/or specified commercial vegetable baby foods;
   - Puddings with or without fruit;
   - Cheese (up to 15g/day until 9 months of age), yoghurt and salt free butter as constituents of savoury or pudding meals;
   - Meat and/or vegetable and/or pulse mixes, with Nutriprem milk and/or specified commercial baby foods which contain meat;
   - Fish and vegetable mixes with Nutriprem milk and/or specified commercial baby foods, which contain fish.

7. Follow-on milk would be introduced at 8 months of age to bottle-fed infants. This or breast milk would be the main drink until one year of gestation corrected age (GCA).

8. Guidelines to parents on the varieties and combinations of weaning foods, which were appropriate for each stage of weaning, would be provided.


2.2 Determination of Achievable Growth Outcomes

The projected growth outcomes, which were believed to be achievable by infants following the dietary strategy (Section 2.1), were derived from the following sources:
   - Consultations with the Clinical Collaborator, Dr K.D. Foote, Consultant Paediatrician, the Study Supervisors, Dr J.B. Morgan and Dr J.A. Bishop and Mr J.A.C. Wells, Paediatric Nutrition Manager, Cow & Gate Nutricia;
   - A review of published growth studies;
The advice of Prof. B. A. Wharton, Consultant Paediatrician, Institute of Child Health, London;

The advice of Dr I. Kovar, Neonatologist, Chelsea & Westminster Hospital.

The mean differences in growth outcomes (weight, supine length and head circumference) between the dietary strategy intervention group and a control group, which it was hoped the study would produce at one year GCA, are outlined. These were:

\[
\text{Weight} = 0.5 \text{ kg}; \text{ Length} = 1.0 \text{ cm}; \text{ Head circumference} = 0.5 \text{ cm}
\]

The calculations used to derive these outcomes are shown in Appendix II.

2.3 Study Design

A comparative study of preterm babies was conducted to test the Preterm Infant Feeding Strategy (Section 2.1). A drop out rate of approximately 10% was anticipated.

Two subject groups of preterm infants followed different nutritional regimens for one year from around zero weeks gestation corrected age (GCA), before weaning has begun, up to one year GCA, in a blinded randomised prospective study.

The achievable outcomes which it was hoped the year long intervention weaning regimen would produce were mean differences in growth between the intervention group (A) and the control group (B). See Section 2.2.

2.4 Subjects and Recruitment

2.4.i. Subject Numbers

In order that the tests of the effect of the nutritional regimen, the Preterm Infant Feeding Strategy, on the rate of weight, length and head circumference growth against that of current weaning practice had 80% power at the 5% significance level; thirty infants per group were required. The sample size calculations were undertaken by Dr Alan Kimber, Statistician, University of Reading, from the minimum desired growth outcomes and the data on which the predicted growth outcomes was based (Section 2.2, Appendix II).
2.4.11. Subject Characteristics

Preterm infants, with a birth weight below 2.2 kg, whose parents consented to their participation in the study, were recruited from the Royal Hampshire County Hospital, Special Care Baby Unit, Winchester until sufficient numbers had been included to form two subject groups.

The Royal Hampshire County Hospital serves the area of Middle and North Hampshire. However, the Neonatal Unit accommodates babies from a much wider catchment area. The families of infants recruited to the study resided in Winchester, Eastleigh, Andover, Southampton, Basingstoke, Alton, The New Forest and many parts of rural Hampshire. One family resided in the neighbouring county of Wiltshire.

2.4.iii. Sociodemographic Characteristics of the Subjects' Families:

Basic details about each infant's family background were collected and recorded on a Family Data Record Sheet (Figure 2.4.i.), at one of the first two meetings with the family of the subject. The current or previous occupations of both parents were recorded, together with the number of people normally resident in the household. The birth date, height and weight of both parents were requested. The job description of the resident major breadwinner was used for socio-economic classification.

2.4.iv. Clinical Records

A clinical record sheet for each baby in the study was completed from the hospital medical notes for the period from birth until discharge from the neonatal unit. The clinical record (Fig. 2.4.ii.a, b, & c.) detailed the medical treatment and the nutritional support provided to each subject during his/her stay in the neonatal unit.

The gestational age of each baby at birth was estimated by the relevant obstetric consultant from information provided by the mother and the results of an ultrasound examination performed at around 19 weeks post-conception.

Clinical conditions denoted in the list in Figure 2.4.ii.c were recorded on the reverse side of the Clinical Record Sheet.
2.4.v. Exclusions

Infants who were diagnosed in the neonatal unit with severe bronchopulmonary dysplasia or severe neurological impairment, or who were discharged from hospital suffering from a serious pathological condition, or who were unable to feed orally upon discharge were not included in the study.

**Figure 2.4.i. Family Data Record sheet**

<table>
<thead>
<tr>
<th>FAMILY DATA RECORD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baby's Name:</strong></td>
</tr>
<tr>
<td>D.o.B.</td>
</tr>
<tr>
<td>Address</td>
</tr>
<tr>
<td>Tel. No.</td>
</tr>
<tr>
<td><strong>Mother's Name:</strong></td>
</tr>
<tr>
<td>D.o.B.</td>
</tr>
<tr>
<td>Occupation (present/previous)</td>
</tr>
<tr>
<td><strong>Father's Name:</strong></td>
</tr>
<tr>
<td>D.o.B.</td>
</tr>
<tr>
<td>Occupation (present/previous)</td>
</tr>
<tr>
<td><strong>Family Size:</strong></td>
</tr>
<tr>
<td><strong>Allergy/smoking status:</strong></td>
</tr>
<tr>
<td>Asthma</td>
</tr>
<tr>
<td>Eczema</td>
</tr>
<tr>
<td>Hay fever</td>
</tr>
<tr>
<td>Smoking</td>
</tr>
<tr>
<td><strong>Name of GP:</strong></td>
</tr>
<tr>
<td><strong>Dates of blood sampling:</strong></td>
</tr>
<tr>
<td><strong>Dates of growth measurements:</strong></td>
</tr>
<tr>
<td><strong>Dates of diary completion:</strong></td>
</tr>
</tbody>
</table>
Figure 2.4.ii.a. Clinical record of birth details and nutritional support during post-birth in-patient care completed for each infant

### BIRTH AND NEONATAL UNIT RECORD

<table>
<thead>
<tr>
<th>Name:</th>
<th>Study Code No:</th>
<th>Hosp. Code No:</th>
</tr>
</thead>
</table>

#### Birth Details:

<table>
<thead>
<tr>
<th>D O B</th>
<th>Sex</th>
<th>EDD</th>
<th>Gestational Age</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Apgar at 5min.</th>
<th>Birth Wt (g)</th>
<th>Length(cm)</th>
<th>H.C.(cm)</th>
</tr>
</thead>
</table>

#### Mother’s Details:

<table>
<thead>
<tr>
<th>Name</th>
<th>Tel. No.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Address</th>
<th>D O B</th>
<th>Parity</th>
<th>Date LMP</th>
<th>Ethnic Group:</th>
</tr>
</thead>
</table>

#### Feeding Details:

<table>
<thead>
<tr>
<th>Type of Feeding</th>
<th>yes</th>
<th>no</th>
<th>From date</th>
<th>To date</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral Feeding commenced</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Oral Feeding (≥120ml/kg/d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breast Milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BM Fortifier</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LBW Formula alone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplementary LBW Formula</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Formula alone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplementary Standard Formula</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Discharge:

<table>
<thead>
<tr>
<th>Date of discharge from N.U.</th>
<th>Weight (kg) at discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of feeding</td>
<td>Volume mls/day</td>
</tr>
<tr>
<td>Name of any formula</td>
<td>Prescribed vitamin supplement (name &amp; dosage)</td>
</tr>
<tr>
<td>Prescribed mineral supplement (name &amp; dosage)</td>
<td>GP name/address</td>
</tr>
</tbody>
</table>
Figure 2.4.ii.b. Clinical record of procedures during post-birth in-patient care completed for each infant

Clinical Details:

Name of Consultant:

Commonly Used Clinical Interventions:

<table>
<thead>
<tr>
<th>Procedure</th>
<th>yes</th>
<th>no</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surfactant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steroids given</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Transfusion(s)</td>
<td></td>
<td></td>
<td>Total Vol. Transfused =</td>
</tr>
<tr>
<td>Oxygen</td>
<td></td>
<td></td>
<td>Max. Fi O₂ after stabilisation =</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Date finally out of O₂ =</td>
</tr>
</tbody>
</table>

Figure 2.4.ii.c. Major neonatal clinical conditions

Major Clinical Conditions:

Please give details, including the date of onset and severity.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraventricular Haemorrhage</td>
<td>IVH</td>
<td>≥ grade III;</td>
</tr>
<tr>
<td>Respiratory Distress Syndrome</td>
<td>RDS</td>
<td>based on clinical/x-ray diagnosis;</td>
</tr>
<tr>
<td>Transient Tachypnoea of Newborn</td>
<td>TTN</td>
<td>needs O₂ &lt; 24hrs;</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>PTX</td>
<td>needing chest drain;</td>
</tr>
<tr>
<td>Pneumonia</td>
<td></td>
<td>clinically diagnosed;</td>
</tr>
<tr>
<td>Apnoea</td>
<td></td>
<td>respiratory support required, e.g. ventilation or CPAP;</td>
</tr>
<tr>
<td>Other Respiratory Problems</td>
<td>ORP</td>
<td>specify;</td>
</tr>
<tr>
<td>Sepsis</td>
<td></td>
<td>+ve blood, CSF, or urine culture and clinical features;</td>
</tr>
<tr>
<td>Suspected Sepsis</td>
<td>SS</td>
<td>-ve cultures, antibiotics ≥ 5 days, clinical features &amp; x-ray changes, feeding stopped for ≥ 5 days, no x-ray changes, feeding stopped ≥ 5 days;</td>
</tr>
<tr>
<td>Necrotising Enterocolitis</td>
<td>NEC</td>
<td></td>
</tr>
<tr>
<td>Suspected NEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seizures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Diagnoses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32
2.4.vi. Recruitment Method

An information letter to be given to the parents of preterm babies was drawn up, which provided details of the study and its requirements. It also stressed the confidentiality and anonymity with which all data would be treated. It was freely available in the Special Care Baby Unit (SCBU). See Appendix III.

Mothers of suitable infants, who expressed an interest in participating in the study to a member of the SCBU staff, were invited to join the study by Dr Keith Foote, Consultant Paediatrician, prior to discharge of the infant from the Special Care Baby Unit. In addition, interested parents could discuss the study and its requirements with the researcher, before signing the consent form. Written confirmation of participation was also sought from the family's General Practitioner. See Appendix III.

Early in 1998, health visitors in Hampshire were notified about the study in consultation meetings arranged by Anne Kelly, Health Visitor Manager, Eastleigh & Winchester Health Trust and Sue Wilks, Health Visitor Manager, Andover Health Trust. An information letter for Health Visitors was left with each study family to pass to their particular health visitor. See Appendix III.

An undertaking was given to the Winchester and Local Research Ethics Committee to treat all parents who agreed to join the study with the utmost consideration throughout the study's duration. Copies of all data relating to their baby's growth and biochemical status were supplied to each infant's parents, if desired. In addition, the parents could contact the researcher directly to discuss any problems associated with the study or their infant's feeding.

Babies were assigned to either the intervention group (A) or the control group (B) by the use of sealed envelopes, which the Statistician, Dr A. Kimber, had prepared. To ensure the same sex ratio and approximately the same mean birth weight in both groups, the randomisation was stratified by sex and birth weight.

Neither the paediatrician nor the parents knew to which group a particular infant had been assigned throughout the study. The researcher was only apprised of the group allocation of each subject after the first growth assessment and blood test.

**Intervention Group (A):** Infants in this group were weaned according to the Preterm Infant Feeding Strategy. The low birth weight infant milk ‘Nutriprem’, manufactured by Cow & Gate, Trowbridge, Wiltshire, which was supplied free of charge to parents, was used for mixing with dry foods and as a liquefying medium for home made meals.
Control Group (B): Infants in this group were weaned according to the current most commonly advised practice. This was determined from the results of a survey of Neonatal Special Care Units, previously conducted by the researcher (Marriott et al, 1999), and the Weaning Report (DoH, 1994).

Medical care and advice was provided to individual families in both groups by health visitors, general practitioners and the relevant paediatrician, as per normal practice.

2.5 Development of Suitable Solid Foods for Preterm Infants

2.5.i. Introduction of Solid Foods (Weaning) Recommendations

The Preterm Infant Feeding Strategy set minimum values for the levels of energy and protein, which should ideally be supplied by all solid baby foods throughout weaning for the intervention group (A). These are shown in Table 2.5.i.

To promote the growth and development of the control group (B), commercially available solid baby foods with a minimum level of 250kJ energy and 0.5-1.5g protein were recommended for use during the weaning process to provide overall energy and protein values equal to or greater than those in human milk (mean energy value = 250kj and mean protein = 1.3g, DoH, 1994).

Some commercially available baby foods contain up to 5.0g protein/100g and/or 450 kJ/100g. These values were taken as the upper safety limits for protein and energy, respectively, for both groups.

The introduction of foods normally regarded as allergenic (unmodified cow's milk, eggs, fish, citrus fruits and nuts) was actively discouraged before six months of age for all infants. All foods containing gluten were excluded from the first list of recommended foods for babies up to 7-9 months of age.

Parents in the study were free to choose to feed only home prepared foods to their babies, only commercially available baby foods of the recommended nutrient densities, or a combination of the two types of food. Conventional home prepared baby foods have a wide range of energy and protein levels but are usually of a lower nutrient density than commercially available foods (Morgan et al, 1993).

The recommended ranges for protein content and energy for Group A were greater than those occurring in human milk and standard cow’s milk formula.
The protein energy ratios (PER) for the most commonly used milks in the first year of life for preterm infants are:

<table>
<thead>
<tr>
<th></th>
<th>Human Milk</th>
<th>LBW Formula</th>
<th>Standard Cow's Milk Formula</th>
<th>Follow-on Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.4% - 8.7%</td>
<td>12.5% - 13.3%</td>
<td>8% - 10.4%</td>
<td>10% - 14.5%</td>
</tr>
</tbody>
</table>

(DoH Report 1994; Tsang et al, 1993)

Only the usual range of PER is quoted, the maximum range will be larger for milks with a variable protein/energy composition.

<table>
<thead>
<tr>
<th>Table 2.5.i. Recommendations for energy and protein levels in all solid baby foods for group A and for commercially available baby foods for group B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Protein Recommendations</td>
</tr>
<tr>
<td>------------------------------------</td>
</tr>
<tr>
<td>Minimum Energy/100g</td>
</tr>
<tr>
<td>Minimum Protein Savoury &amp; Cereal Foods/100g</td>
</tr>
<tr>
<td>Minimum Protein Fruit Puddings &amp; Desserts/100g</td>
</tr>
<tr>
<td>Possible Range of Energy/100g</td>
</tr>
<tr>
<td>Protein Range in Savoury &amp; Cereal Foods/100g</td>
</tr>
<tr>
<td>Protein Range in Fruit Puddings &amp; Desserts/100g</td>
</tr>
<tr>
<td>Normal Range of PER/ Savoury &amp; Cereal Foods</td>
</tr>
<tr>
<td>Normal Range of PER / Fruit Puddings &amp; Desserts</td>
</tr>
</tbody>
</table>

2.5.ii. Suitable Solid Foods (Weaning Foods) for the Intervention Group

Practical experiments were performed to produce suitable first cereal and baby milk meals with an enhanced energy, protein, calcium and micromineral density, which would conform to the recommendations in Table 2.5.i. Various first baby cereals were mixed to an appropriate consistency with a formula milk manufactured specifically for low birth weight babies, Nutriprem, (supplied by Cow & Gate, Trowbridge). Nutriprem was used, in preference to standard milk formula, to improve the protein, calcium, iron, zinc, selenium and long chain polyunsaturated fatty acid content of cereal based meals.
The cereal foods, Baby Rice, Farex and Farley's Gluten Free Rusks, when mixed with Nutriprem to a creamy consistency, were found to conform to the Weaning Hypothesis recommendations for energy and protein, and were included in the Feeding Guides as suitable choices for first cereal foods.

Home prepared savoury and pudding meals were devised by mixing pureed vegetables, pureed fruits, pureed meats and dairy products, which are customarily used in the first two or three months of weaning, in appropriate combinations with Nutriprem, as the liquefying medium to provide the required consistency.

The nutrient composition and the renal solute load (RSL) of each mix was calculated to ensure that the protein intake and the urinary load resulting from the putative mixture fell within the usual, acceptable ranges of protein and RSL for infants. The nutritional analyses are shown in Tables 2.5.ii, iii, and iv.

Values for the nutrient content of individual foods were taken from The Composition of Foods: 5th edition (Holland et al, 1995) and the nutrient analyses supplied by the relevant Baby Food Manufacturers.

**Table 2.5.ii. Cereal and milk mixes: nutrient composition/100g**

<table>
<thead>
<tr>
<th></th>
<th>Baby Rice &amp; Nutriprem</th>
<th>Farex &amp; Nutriprem</th>
<th>Original Rusk &amp; Nutriprem</th>
<th>Gluten Free Rusk &amp; Nutriprem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy kj (kcal)</td>
<td>426 (102)</td>
<td>456 (108)</td>
<td>775 (187)</td>
<td>903 (215)</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>2.8</td>
<td>3.3</td>
<td>3.7</td>
<td>5.1</td>
</tr>
<tr>
<td>CHO (g)</td>
<td>13.7</td>
<td>13.8</td>
<td>31.2</td>
<td>31</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>1.9</td>
<td>4.4</td>
<td>4.8</td>
<td>7.7</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>94</td>
<td>146</td>
<td>240</td>
<td>304</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.9</td>
<td>1.5</td>
<td>6.2</td>
<td>8.1</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>0.8</td>
<td>1.0</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Composition</td>
<td>1:12</td>
<td>1:10</td>
<td>1:2.1</td>
<td>1:1.6</td>
</tr>
<tr>
<td>PER (%)</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td>9.5</td>
</tr>
<tr>
<td>Energy (kj) / 6g tsp</td>
<td>26</td>
<td>27</td>
<td>31</td>
<td>36</td>
</tr>
</tbody>
</table>
### Table 2.5.iii. Savoury meals: nutrient composition/100g

<table>
<thead>
<tr>
<th></th>
<th>Potato &amp; Nutriprem</th>
<th>Potato, Carrot &amp; Nutriprem</th>
<th>Chicken, Potato, Carrot &amp; Nutriprem</th>
<th>Lamb, Potato, Broccoli &amp; Nutriprem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy kj (kcal)</strong></td>
<td>315 (75)</td>
<td>270 (64)</td>
<td>308 (73)</td>
<td>333 (79)</td>
</tr>
<tr>
<td><strong>Protein (g)</strong></td>
<td>2.0</td>
<td>1.7</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>CHO (g)</strong></td>
<td>14</td>
<td>11.3</td>
<td>9.8</td>
<td>9.0</td>
</tr>
<tr>
<td><strong>Fat (g)</strong></td>
<td>1.5</td>
<td>1.6</td>
<td>2.3</td>
<td>2.7</td>
</tr>
<tr>
<td><strong>Calcium (mg)</strong></td>
<td>37</td>
<td>41</td>
<td>48</td>
<td>49</td>
</tr>
<tr>
<td><strong>Iron (mg)</strong></td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Zinc (mg)</strong></td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Composition by wt</strong></td>
<td>1 : 0.5</td>
<td>1 : 0.5 : 0.75</td>
<td>1 : 4 : 2 : 5</td>
<td>1 : 3.5 : 2 : 4</td>
</tr>
<tr>
<td><strong>PER (%)</strong></td>
<td>11</td>
<td>11</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td><strong>Energy (kj) / 6g tsp</strong></td>
<td>22</td>
<td>21</td>
<td>29</td>
<td>33</td>
</tr>
</tbody>
</table>

### Table 2.5.iv. Pudding/fruit meals: nutrient composition/100g

<table>
<thead>
<tr>
<th></th>
<th>Banana &amp; Nutriprem</th>
<th>Strawberry &amp; Fromage Frais</th>
<th>Banana, Rice &amp; Nutriprem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy kj (kcal)</strong></td>
<td>393 (93)</td>
<td>96</td>
<td>413 (98)</td>
</tr>
<tr>
<td><strong>Protein (g)</strong></td>
<td>1.4</td>
<td>4.1</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>CHO (g)</strong></td>
<td>20.7</td>
<td>11.1</td>
<td>19.1</td>
</tr>
<tr>
<td><strong>Fat (g)</strong></td>
<td>1.0</td>
<td>4.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Calcium (mg)</strong></td>
<td>22</td>
<td>55</td>
<td>44</td>
</tr>
<tr>
<td><strong>Iron (mg)</strong></td>
<td>0.4</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Zinc (mg)</strong></td>
<td>0.3</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Composition by wt</strong></td>
<td>1 : 0.2</td>
<td>1 : 1.3</td>
<td>12:0.75:9</td>
</tr>
<tr>
<td><strong>PER (%)</strong></td>
<td>6</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td><strong>Energy (kj) / tsp</strong></td>
<td>24</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>
2.5.iii. Renal Solute Loads of Weaning Foods

The renal solute load (RSL) of a meal is the total quantity of solutes which must be excreted via the kidneys. The solutes comprise non-metabolisable dietary components, which are excess to requirements, especially electrolytes and metabolic end products, which are produced mainly from nitrogenous compounds (Bergmann et al, 1974).

The ability to concentrate urine may be low in preterm infants. Hence, the potential renal solute load (PRSL) of a meal is usually calculated for preterm infants (Lorenz & Kleinman, 1988). This is made up of the possible urea production from a given protein intake plus a contribution from the main minerals in the diet which assumes complete excretion of the ingested electrolytes.

\[
PRSL = \text{protein intake (g)/0.175 + Na + K + P + Cl}
\]

where the electrolyte intakes of sodium (Na), potassium (K), phosphorus (P) and chlorine (Cl) are expressed in millimoles (Bergmann et al, 1974).

The Potential Renal Solute Loads (PRSL) of meals incorporating Nutriprem were calculated from the weights of the ingredients and milk used to produce a meal of appropriate consistency. The method of calculation is shown for a Baby Rice and Nutriprem mix in figure 2.5.i.

**Figure 2.5.i. Potential renal solute loads**

<table>
<thead>
<tr>
<th></th>
<th>Wt in rice</th>
<th>Wt in Nutriprem</th>
<th>Total Wt</th>
<th>PRSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>0.3</td>
<td>1.2</td>
<td>1.5</td>
<td>8.57</td>
</tr>
<tr>
<td>Na (mg)</td>
<td>0.8</td>
<td>20.5</td>
<td>21.3</td>
<td>0.93</td>
</tr>
<tr>
<td>K (mg)</td>
<td>4.8</td>
<td>40</td>
<td>44.8</td>
<td>1.15</td>
</tr>
<tr>
<td>P (mg)</td>
<td>4</td>
<td>25</td>
<td>29</td>
<td>0.94</td>
</tr>
<tr>
<td>Cl (mg)</td>
<td>1.2</td>
<td>24</td>
<td>25.2</td>
<td>0.71</td>
</tr>
</tbody>
</table>

\[
PRSL = 12.3 \text{ mosm.}
\]

\[
PRSL \text{ for } 100\text{g of mixture} = 22.8 \text{ mosm.}
\]

\[
PRSL \text{ for each 6 g (1tsp) intake} = 1.4 \text{ mosm.}
\]

Atomic Masses: Na 23, K 39, P 31, Cl 35.5
The Potential Renal Solute Loads of baby meal recipes devised for use in the Feeding Guides have been calculated. Some examples are shown in Table 2.5.v.

For comparison, breast milk has an average renal solute load of 8.6 mosm./100ml and the renal solute load of standard cow's milk formula varies between 9.3-12.6 mosm/100ml.

Table 2.5.v. Examples of potential renal solute loads of baby meal recipes

<table>
<thead>
<tr>
<th>Recipe</th>
<th>PRSL/100g mosm.</th>
<th>PRSL/tsp mosm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baby Rice and Nutriprem</td>
<td>22.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Farex and Nutriprem</td>
<td>27.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Gluten Free Rusk and Nutriprem</td>
<td>42</td>
<td>1.7</td>
</tr>
<tr>
<td>Potato, Carrot and Nutriprem</td>
<td>18.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Tinned Strawberry and Fromage Frais</td>
<td>30.2</td>
<td>2.4</td>
</tr>
<tr>
<td>Lamb, Potato, Broccoli and Nutriprem</td>
<td>39.1</td>
<td>3.9</td>
</tr>
</tbody>
</table>

2.5.iv. Urinary Concentrations

The urinary concentration \( C_{\text{urine}} \) which could arise from a particular baby food can be calculated from the Potential Renal Solute Load (PRSL) of the food if the infant's weight and growth rate are known.

\[
C_{\text{urine}} = \frac{(\text{PRSL}_{\text{food}} - \text{PRSL}_{\text{growth}})}{W_{\text{food}} - W_{\text{extra renal}}}
\]

where:

- \( \text{PRSL}_{\text{food}} \) is the total PRSL for the food intake.
- \( \text{PRSL}_{\text{growth}} \) is the proportion of PRSL utilised for growth, 1g of weight gain is assumed to be equivalent to 0.9 mosm/day.
- \( W_{\text{food}} \) is the amount of water available from dietary sources, including water produced by food oxidation. 0.9 litres of water are available / litre of formula and baby foods.
- \( W_{\text{extra renal}} \) is an allowance for extra renal water losses. These are normally small, but for preterm infants a value of 0.07 L/kg/day can be used. The quantity of water required for new growth is very small and can be ignored in the calculation (Bergmann et al, 1974).

For the neonatal preterm infant, urine concentrations should be maintained at or below 400 mosm/l (Bergmann et al, 1974; Lorenz & Kleinman, 1988).
**Example 1:** The overall daily urine concentration can be estimated at the start of weaning for a preterm infant of 3-4 months of age weighing 3.5 kg and with a conservative assumed growth rate of 20g/day. The average intake of formula (confirmed by the first few milk intake diaries) was estimated to be 600ml/day.

**Calculation 1:** Daily urine concentration for intake of standard formula (600ml) with a rice and Nutriprem solid meal (50g).

\[
\begin{align*}
C_{\text{urine}} &= \frac{(\text{PRSL}_{\text{food}} - \text{PRSL}_{\text{growth}})}{(\text{W}_{\text{food}} - \text{W}_{\text{extra renal}})} \\
\text{PRSL}_{\text{food}} &= \frac{600 \times 110 + 50 \times 22.8}{1000} = 77.4 \text{ mosm} \\
\text{PRSL}_{\text{growth}} &= 20 \times 0.9 = 18 \text{ mosm} \\
\text{W}_{\text{food}} &= 0.9 \times 0.65 = 0.59 \text{ mosm} \\
\text{W}_{\text{extra renal}} &= 0.07 \times 3.5 = 0.25 \text{ mosm} \\
C_{\text{urine}} &= 77.4 - 18 = 174.7 \\
&= 0.59 - 0.25 \\
&= 175 \text{ mosm/l}
\end{align*}
\]

**Example 2:** When meat is introduced at > 4 months of age, the preterm infant would typically weigh 4-5 kg and would eat more solid foods/day, the urine concentration can be calculated as above.

**Calculation 2:** Daily urine concentration for intake of standard formula (600ml) and eating 100g of a lamb, potato, broccoli and Nutriprem meal /day (worst case scenario).

\[
C_{\text{urine}} = 323 \text{ mosm/l}
\]

The values of urinary concentration in the above examples, for a typical preterm infant are still under the recommended maximum of 400mosm/l (Fomon 1974; Tsang & Nichols, 1988).

2.5.v. Energy and Nutrient Dense Commercial Baby Foods for the Intervention Group

A survey of commonly available commercial baby foods was conducted to establish the range and number of baby foods, which complied with the Preterm Infant feeding Strategy. Examples of suitable first weaning foods for the intervention group are listed in Appendix IV. Additionally, the survey was used to delineate appropriate commercially available solid foods for the control group.
2.6 The Preterm Infant Feeding Guides for Parents

2.6.i. Feeding Guide Sets
Two separate sets of Feeding Guides, one set for each group in the study, were produced by the researcher for the three distinct stages of the weaning process (Health Education Authority, 1997) for use up to one year of gestation corrected age. Each set of Feeding Guides was presented as a set of three separate booklets, each booklet corresponding to one of the three distinct stages of weaning. Thus, parents received three consecutive Feeding Guides. Each Feeding Guide was entitled First, Second or Third Feeding Guide and was bound in a different coloured cover to reduce confusion for parents and the researcher and to add a touch of brightness.

The First, Second and Third Feeding Guides for parents in the intervention group (A) were bound in green, red and emerald covers, respectively. See Appendix V. The First, Second and Third Feeding Guides for parents in the control group (B) were bound in yellow, aquamarine and blue covers, respectively. See Appendix VI.

2.6.ii. The First Feeding Guides
The definition of weaning, its stages and the general rules of good practice for infant solid feeding were included in both versions of the First Guide, together with sections on milk feeding and drinks suitable for babies up to one year of gestation corrected age. Both guides concluded with a list of foods to avoid in the first stage of weaning and advice on the signs of readiness for the second stage of weaning. The advice in these sections was taken primarily from Weaning and the Weaning Diet (DoH, 1994) and Weaning your baby (Health Education Authority, 1997). The definitions of the three stages of weaning and the advice on milk feeding are shown in Figure 2.6.i. and ii.

Each guide provided age, weight and developmental stage recommendations for commencing weaning. These were different for the intervention and control groups, and were in accordance with the Preterm Infant Feeding Strategy (PIFS) and Department of Health (1994) recommendations, respectively.

Each version of the First Feeding Guide contained a recommended order of introduction for different types of food, together with a list of suitable commercially available baby foods and recipes for home made foods for each food type. The recommendations conformed to PIFS for the intervention group and to the Department of Health (1994) for the control group.
Both versions of the guide recommended the exclusion of foods containing gluten until after six months of age. All commercial first stage solid (weaning) foods, which contain wheat, barley, rye or oats, were marked with an asterisk to denote the presence of gluten.

**Figure 2.6.i. The stages of weaning**

**What is Weaning?**

The gradual change from a milk only diet to milk and foods eaten by the rest of the family is called WEANING.

Your baby needs to get used to eating food from a spoon rather than just drinking milk through a teat. This is a gradual process. At first, the baby must learn to take runny, bland foods from a small spoon. The variety and consistency of the solid foods is gradually increased at a pace to suit your baby.

**The introduction of solid foods is usually divided into stages.**

**Stage One:** Only pureed foods are used. Only a limited range of foods is offered to the baby. These include some cereals, some vegetables and fruit, simple puddings and lean meats. This stage should last 3-6 months.

**Stage Two:** Mashed foods and then chopped foods are introduced. A wider variety of foods is offered including wheat products, eggs and fish. As the baby’s teeth develop then soft finger foods such as buttered bread and toast can be given.

**Stage Three:** More family foods are introduced. The food should be minced or chopped for meals. Biscuits, fruit and other finger foods should be given between meals. At around one year of age, the baby can be encouraged to feed him/herself.

**Figure 2.6.ii. Advice on milk feeding for all infants**

**Milk Feeds:**
Your baby should continue to receive breast or a baby formula milk, as his/her main drink, until he/she is at least one year old. Cow’s milk (normal, doorstep milk) should not be used as a drink before one year of age. A few weeks after weaning has begun, small amounts of cow’s milk products e.g. fromage frais, custard and yoghurt can be used in baby meals.
2.6.ii. The Intervention Group (A) First Feeding Guide

All foods recommended in the guide complied with energy and protein contents specified in Table 2.5.i. For the intervention group, recipes of the type listed in Table 2.5.ii, iii and iv were included in the guide together with commercial foods outlined in Appendix IV. The recommendations for starting weaning and information about and directions for use of the low birth weight milk, Nutriprem, are shown in Figures 2.6.iii. and 2.6.iv. The order of introduction of different types of food for the intervention group is portrayed in Figure 2.6.v.

**Figure 2.6.iii. Recommendations for starting weaning for the intervention group (A)**

**When to start**

1. Your baby should be around 3 months old.
2. Your baby should weigh at least 7½ lb (3.5 kg).
3. Your baby’s expected date of delivery should be past.
4. You feel your baby is ready for something new. You may sense this because he/she may seem less satisfied with baby milk alone.
5. He/she may be more wakeful and may dribble more.
6. His/her weight gain may not be so good.

When your baby has reached, the age and weight above, and you feel he/she is ready, then you should begin weaning.

**Figure 2.6.iv. Information on Nutriprem for group A**

**The Special Milk**

All recommended cereals and home-prepared foods should be mixed with enough of the special milk, Nutriprem, to make a thin creamy mix.

The special milk called Nutriprem is a milk formula specially produced to meet the feeding needs of low birth weight babies.

It is widely used in the Special Care Baby Units of hospitals, some babies are discharged from the hospital with Nutriprem as their regular milk.

We believe it will make a more nutritious mixing milk for baby food than regular milk formula.

Nutriprem will be provided free of charge, in small, ready-to-use bottles.

Warm the mix of food and special milk by standing the feeding dish in a jug or bowl of hot water.

Immediately, replace the top on any unused milk left in the bottle and store in a refrigerator for the rest of the day.

A new bottle of milk must be used each day.
Figure 2.6.v. Group A recommendations for order of introduction of different food types

**From Week 1 of Weaning Onwards**

**I. FIRST CEREALS**

Baby rice mixed with baby milk is the first choice for most babies. Offer this to your baby once a day for the first week or two. If your baby rejects baby rice, try one of the other listed cereals. As your baby gets used to the spoon and learns to swallow, offer the cereal twice a day or introduce one of the other cereals at a different time of day. Gradually increase the amount of cereal you offer to your baby.

**From Weeks 2-4 of Weaning Onwards**

**II. VEGETABLES**

After a week or two, introduce one or two vegetables. Vegetables can be home prepared or you can use a ready prepared baby food. The vegetable should be offered at a different time of day to the cereal. Potato is the easiest and most acceptable first vegetable for babies. Home-prepared vegetables should be pureed, or mashed and pushed through a sieve.

**From Weeks 3-8 of Weaning Onwards**

**III. PUDDINGS AND FRUIT**

When your baby is happy to eat from a spoon, you can start introducing puddings with or without fruit. These can be introduced so that your baby is offered solids up to three different times during the day, or as a dessert course after the vegetables. Make sure that you offer more savoury and cereal foods to your baby than sweet foods.

**From Week 6 of Weaning Onwards**

**IV. BUTTER, CHEESE, CREAM, FROMAGE FRAIS AND YOGHURT**

When your baby has accepted a range of cereals, vegetables and puddings, then unsalted butter and olive oil can be used for cooking baby’s food or mixing with it. A small amount of a grated hard cheese, such as Cheddar, can be melted with vegetable dishes to add flavour, or a small amount of cream cheese can be mixed in. Similarly, cream, fromage frais and full fat plain yoghurt can be used to improve the texture and flavour of baby food. Please note that your baby should eat less than 15g (½oz) of cheese per day. This is because of the high salt content of cheese. Your baby should now accept a solid feed three times a day. Usually, a cereal will be offered at breakfast time. A vegetable dish made with butter, cream, cheese or olive oil will be offered at lunchtime and a pudding for supper.

**From Weeks 6-12 of Weaning Onwards**

**V. MEAT WITH VEGETABLES**

When your baby is able to eat from a spoon easily and is taking a good variety of foods at least twice a day, then you can begin to introduce meat to your baby’s diet. Meat is a very good source of the protein and the minerals your baby needs to grow.
2.6.iii. The Control Group (B) First Feeding Guide

For the control group, similar recipes to those for Group A were included in the Guide but the mixing milk was the baby's normal milk and the food combinations were less restrictive. The recommendations for when to begin weaning and the order of introduction for different foods are shown in Figures 2.6.vi. and 2.6.vii.

Figure 2.6.vi. Recommendations for starting weaning for the control group (B)

<table>
<thead>
<tr>
<th>When to start</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Your baby should be at least 4 months old.</td>
</tr>
<tr>
<td>2. Your baby should weigh at least 11 lb (5kg).</td>
</tr>
<tr>
<td>3. Your baby should be able to take food from a spoon.</td>
</tr>
<tr>
<td>4. You feel your baby is ready for something new. You may sense this because he/she may seem less satisfied with baby milk alone.</td>
</tr>
<tr>
<td>5. He/she may be more wakeful and may dribble more.</td>
</tr>
<tr>
<td>6. His/her weight gain may not be so good.</td>
</tr>
</tbody>
</table>

When your baby has reached the age and weight above, and you feel he/she is ready, then you should begin weaning.

Figure 2.6.vii. Group B recommendations for order of introduction of different food types

<table>
<thead>
<tr>
<th>From Week 1 of Weaning Onwards.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. FIRST CEREALS</td>
</tr>
<tr>
<td>II. FRUIT AND VEGETABLES</td>
</tr>
<tr>
<td>III. PUDDINGS</td>
</tr>
<tr>
<td>IV. BUTTER, CHEESE, CREAM, FROMAGE FRAIS AND YOGHURT</td>
</tr>
<tr>
<td>V. MEAT WITH VEGETABLES</td>
</tr>
</tbody>
</table>
Appropriate commercial foods with energy and protein contents equal to or greater than those specified in Table 2.5.i. were listed after each food type. Thus, this group had a considerably larger range of commercial foods and a wider choice of home made dishes to utilise when introducing solid foods to their babies.

2.6.iv. The Second Feeding Guides

The main recommendations in the Second Guides concerned the introduction of chewable food i.e. lumps, minced food and finger foods, an increase in the range of foods and the change to a ‘follow-on milk’ for formula fed infants. The guides contained a graduated programme for changing the texture of an infant’s food and increasing the types of food eaten. A list of suitable proprietary baby foods for each type of meal and suggested menus were also included. The itemised baby foods in each version of the guide conformed to the protein and energy requirements for the intervention and the control groups.

Both versions of the guide included the same advice about when a baby is ready to progress to the second stage of weaning, which is detailed in Figure 2.6.viii.

Further information on suitable drinks for babies up to one year of age, other than breast or formula milks, and foods to avoid up to one year of age are included in both Second Feeding Guides.

Figure 2.6.viii. Readiness for the second stage of weaning for groups A & B

<table>
<thead>
<tr>
<th>When to start</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Your baby should be at least seven to eight months old.</td>
</tr>
<tr>
<td>2. Your baby should be eating three meals of solid foods a day.</td>
</tr>
<tr>
<td>3. Your baby should be able to sit in a high chair.</td>
</tr>
<tr>
<td>4. Your baby should be able to eat finely mashed vegetables, like potato and carrot.</td>
</tr>
<tr>
<td>5. Your baby should be eating several different types of vegetable, meat, fruit and pudding.</td>
</tr>
<tr>
<td>6. You feel your baby is ready to cope with new experiences.</td>
</tr>
</tbody>
</table>

When your baby has reached the age and stages above, and you feel he/she is ready, then you should begin the second stage of weaning.
2.6.v. The Intervention Group (A) Second Feeding Guide
Specific guidance about the advisability of using follow-on formula milks as the main drink for formula fed babies and as the mixing milk for solid foods for all intervention group infants, was provided. See Figures 2.6.ix. & x.

Figure 2.6.ix. Use of follow-on milks as a formula milk for the intervention group (A)

Milk Feeds

- Your baby should continue to receive breast milk or a baby formula milk, as his/her main drink until he/she is at least one year old. Give this milk to your baby on waking and at bedtime, as well as around meal times.
- For bottle-fed babies, at least 500ml of baby formula milk should be offered to your baby every day.
- Cow's milk (normal, doorstep milk) should not be used as a drink before one year of age.
- When your baby is eight months old, you may wish to change his/her bottle milk to a follow-on milk formula, e.g. Cow & Gate Step-up, Milupa Forward or SMA Progress.
- Cow's milk products e.g. cheese, butter, fromage frais, custard and baby yoghurts can be used as part of your baby's meals.

Figure 2.6.x. Use of follow-on milks as a mixing milk for group A

Milk for Mixing

Special milk (Nutriprem):
Cereals, which can be mixed with milk (see Breakfasts), and home-prepared foods should be mixed with enough of the special milk, to make a thick creamy mix. Warm the mix of food and special milk by standing the feeding dish in a jug or bowl of hot water. Immediately, replace the top on any unused milk left in the bottle and store in a refrigerator for the rest of the day. A new bottle of milk must be used each day.

Follow-on milk:
When your baby is eight months old, you can start to use a follow-on milk for mixing with breakfast cereals and home-prepared foods, rather than the 'special milk'. Cow & Gate Step-up, Milupa Forward and SMA Progress are all follow-on milks.
Suitable daily menus were suggested for home-prepared food, one of which is shown in Figure 2.6.xi.

Figure 2.6.xi. Suggested daily menu for the second stage of weaning for group A

<table>
<thead>
<tr>
<th>Suggested Daily Menu for the Second Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast:</strong></td>
</tr>
<tr>
<td>Rusk made with follow-on milk, and buttered toast fingers, or</td>
</tr>
<tr>
<td>Baby porridge made with boiled water, and eggy bread and butter fingers, or</td>
</tr>
<tr>
<td>Weetabix made with follow-on milk, and banana slices or yoghurt.</td>
</tr>
<tr>
<td><strong>Lunch:</strong></td>
</tr>
<tr>
<td><strong>Main Course</strong></td>
</tr>
<tr>
<td>Shepherd’s pie (minced lamb, potato, Milupa gravy) with chopped cabbage, or</td>
</tr>
<tr>
<td>Boiled rice, chopped carrot and minced chicken in a follow-on milk sauce, or</td>
</tr>
<tr>
<td>Chopped pasta, minced beef, chopped broccoli with tinned, chopped tomatoes, or</td>
</tr>
<tr>
<td>Any second stage baby main meal from the recommended list.</td>
</tr>
<tr>
<td><strong>Pudding</strong></td>
</tr>
<tr>
<td>Chopped banana and custard, or</td>
</tr>
<tr>
<td>Rice pudding, or</td>
</tr>
<tr>
<td>Chopped ripe peach and fromage frais, or</td>
</tr>
<tr>
<td>Any first or second stage baby pudding from the recommended list.</td>
</tr>
<tr>
<td><strong>Tea or Supper:</strong></td>
</tr>
<tr>
<td><strong>Main Course</strong></td>
</tr>
<tr>
<td>A boiled egg and toast soldiers, or</td>
</tr>
<tr>
<td>Mashed boiled white fish/chopped fish finger with chopped, tinned tomato, or</td>
</tr>
<tr>
<td>Scrambled egg and chopped spaghetti and chopped tomato, or</td>
</tr>
<tr>
<td>Chopped, cooked cauliflower with mashed pasta and Milupa cheese sauce, or</td>
</tr>
<tr>
<td>Any first or second stage baby savoury meal from the recommended list.</td>
</tr>
<tr>
<td><strong>Pudding</strong></td>
</tr>
<tr>
<td>If required, as for lunch.</td>
</tr>
<tr>
<td><strong>Snacks:</strong></td>
</tr>
<tr>
<td>These may be given as part of the meal or as a snack between meals.</td>
</tr>
<tr>
<td>Fingers of buttered toast, bread and butter soldiers and rusks, fingers of hard cheese, cooked carrot sticks and slices of peeled fruit and baby yoghurts from the recommended list.</td>
</tr>
</tbody>
</table>
2.6.vi. The Control Group (B) Second Feeding Guide
Similar advice about the suitability of follow-on milk for formula fed babies was included in this guide, without the restricted list of brands recommended for Group A. The suggested daily menus were less restrictive than for Group A. See Appendix VI.

2.6.vii. The Third Feeding Guides
Two versions of the Third Feeding Guide, one for each subject group, for the final stage of weaning were prepared. Both versions suggested that when infants were ten months old (postnatal age) or older, the recommendations in the guides could be implemented. The main recommendations included the minimum age for the changeover to cow's milk as a replacement for breast milk or formula as the main milk drink and the gradual transition towards eating the habitual family diet, initially in chopped form, with a consequent increase in the range of foods consumed. The recommendations for both groups for starting the third stage of weaning and for suitable types of milk are shown in Figures 2.6.xii. and 2.6.xiii. respectively.

Both versions of the Guide contained a graduated programme for changing the texture of the infant's food and increasing the variety of food eaten. Suggested menus and a list of suitable proprietary baby foods for each type of meal were also included. The itemised baby foods in each version conformed to the protein and energy requirements for the intervention and the control groups.

Both forms of the guide included 'Healthy Eating Recommendations for Toddlers', nutritional advice for young children compiled by the researcher. See Appendices V and VI.

2.6.viii. The Intervention Group (A) Third Feeding Guide
The only substantive differences between the two Feeding Guides for the final stage of weaning were the suggested daily menus and the recommended list of proprietary baby foods. In both instances, the advice for the intervention group was more restrictive to conform to the delineated energy and protein levels.

One of the suggested menus for the intervention group (A) is shown in Figure 2.6.xiv.

2.6.ix. The Control Group (B) Third Feeding Guide
The list of recommended commercial baby foods conformed to the energy and protein levels specified in Table 2.5.i. See Appendix VI.
WHEN TO START

1. Your baby should be at least 10-15 months old.
2. Your baby should be eating a variety of minced foods, including minced meat or minced pulses.
3. Your baby should be able to eat a variety of finger foods.
4. Your baby should be able to begin to feed himself/herself with a spoon.
5. You feel your baby is ready to cope with new experiences.

When your baby has reached the age and stages above and you feel he/she is ready, then you should begin the third stage of weaning.

MILK FEEDS

- Your baby should continue to receive breast milk or a baby formula milk, as his/her main drink until he/she is one year past the date when he/she was expected to be born. Give this milk to your baby as his/her main drink several times a day.
- For bottle fed babies, about 500 ml (1 pint) of baby formula milk should be offered to your baby every day. This can be reduced to about 350ml (¾ pint) after one year of age.
- Cow's milk (normal, doorstep milk) should not be used as a drink until one year past your baby's expected date of delivery.
- Cow's milk can be used in cooking before your baby is one year old.
- Cow's milk can be used for mixing with dry foods, such as breakfast cereals, from when your baby is one year old.
- For babies and toddlers, use whole (full cream) cow's milk not semi-skimmed or skimmed milk.
Suggested Daily Menus for the Third Stage

Breakfast;
Weetabix mixed with cow’s milk, and buttered toast fingers, or
Porridge made with cow’s milk, or
Rice Krispies or Shreddies mixed with cow’s milk, or
Egg, small pieces of grilled, lean bacon, grilled tomato and bread fingers.

Lunch:
Main Course
Lancashire Hotpot (chopped lamb, potato slices, chopped onion and gravy) with
chopped cabbage, or
Boiled rice, peas and chopped chicken in a tomato or tangy sauce, or
Chopped, roast beef, chopped broccoli with mashed potatoes and gravy.
Pudding
Small pieces of apple pie and custard, or
Jelly and ice cream, or
Sliced peach and fromage frais, or
Fresh fruit.

Tea or Supper:
Main Course
Sandwich squares made with e.g. cheese, tuna or banana, or
Small slices of soft pizza and slices of fresh tomato, or
Scrambled egg with baked beans and toast fingers, or
Vegetable soup with a soft bread roll.
Pudding
Apple or orange slices and/or fruit yoghurt.

Toddler stage meals and puddings from the recommended list can also be used.

Snacks:
These may be given as part of a meal or as a snack between meals.

Milk:
Offer baby milk, cow’s milk, water or diluted fruit juice with meals, or as required.
2.7 Dietary Assessment

2.7.i. Method of Assessment
The customary total daily intake of all foods was determined by recording the weighed intake of all food materials over a seven-day period. For infants who were breast-fed, milk intake was estimated from total suckling time/ breast-feed (Paul et al, 1988).

2.7.ii. Assessment Protocol
Parents were asked to keep a 7 day dietary record of their infant's intake at the gestation corrected ages (GCA) of zero weeks, six months and twelve months. At zero weeks, for formula-fed infants, the type of formula and total volume of formula consumed/day were recorded. Mothers of breast-fed babies were asked to record the total suckling time at each feed. At six and at twelve months of GCA, parents of formula-fed infants recorded the weight of milk and other drinks and the weights and types of solid foods consumed. Parents of breast-fed babies were asked to record the total suckling time at each breast-feed and the weights of solid foods and drinks.
From the beginning of weaning, a simple food record was completed as each new type of food was introduced to the baby. See Section 2.7.iv.
The data arising from the dietary records was used to assess mean daily intakes of energy, protein, carbohydrate, fat, calcium, iron, zinc and copper. A computerised nutrient food data base and dietary analysis programme was used (Diet 5, Robert Gordon University, Aberdeen).

2.7.iii. Milk Diaries
Two forms of a seven-day milk diary were produced for use in the study.
For mothers who wholly or partially breast-fed their babies, a green covered diary had space to record the total time of suckling at each breast-feeding and an additional section in which the volume of any formula feeds was recorded. For mothers who chose to formula feed, a yellow covered diary contained spaces for the mother to record the start and finish volumes for each bottle of milk formula used for a feed. Both versions of the diary had a separate page for each day, and room to record the volume of any water offered to the baby and the name and dosage of vitamin and mineral supplements. Appendix VII.
# FEEDING RECORD

**Baby's Name** | **Code** | **Date of Joining Study:**
--- | --- | ---

**Name of Current Baby Milk:**

- Is boiled water given: 
  - Daily
  - Sometimes
  - Rarely
  - Never

**Name of Vitamin Drops:**
**Date Finished**

**Name of Mineral Drops:**
**Date Finished**

### CHANGES IN MILK FEED

<table>
<thead>
<tr>
<th>Name</th>
<th>Date Started</th>
<th>Date Finished</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### START OF SOLID BABY FOODS

<table>
<thead>
<tr>
<th>Type</th>
<th>Name of particular food/meal</th>
<th>Date 1st given</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Cereal Meal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Kind of Cereal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Kind of Vegetable Meal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Kind of Vegetable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Type of Pudding Meal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Type of Pudding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Kind of Fruit in a Pudding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Kind of Fruit in Pudding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Type of Cheese Meal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Kind of Meat Meal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Kind of Meat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third Kind of Meat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Kind of Fish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Lumpy Food</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second Type of Lumpy Food</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Egg Meal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Type of Finger Food</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Type of Dry Rusk/Biscuit</td>
<td></td>
</tr>
</tbody>
</table>

### INTRODUCTION OF DRINKS OTHER THAN BABY MILK OR WATER

<table>
<thead>
<tr>
<th>Name of Drink</th>
<th>Amount Drunk</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
2.7.iv. Feeding Record
A single sheet Feeding Record was prepared for completion by the parents of all study subjects. To accommodate the variation in the order of introduction of different types of solid foods between the two subject groups, two versions were produced. The version supplied to the intervention group (A) is shown in Figure 2.7.i.
Parents of infants were requested to record the name of each new food type as it was introduced and the date of introduction.

2.7.v. Food Diary
A food diary was devised to assess each infant's daily nutrient intake. Mothers were requested to complete a diary for their infant at six months GCA and twelve months GCA.
Each diary was supplied together with a set of Salter Vista 3002 scales to provide an accurate (±1g), comprehensive 7-day record of each infant's intake of solid food, baby milk and other liquids.
The diary contained an instruction sheet for diary completion and scales use, and an example of a typical baby's food and baby milk intake. In the main body of the diary, each page was divided into a food and a drinks section, and corresponded to a single day's intake. Vitamin and mineral supplements were entered on the final page.
The researcher explained how to fill in the diary and demonstrated the use of the scales to each mother in the study. Appendix VIII.

2.8 Data Collection Protocol

2.8.i. Number and Timing of Visits to Subject Families
Each subject family was visited by the researcher at least six times over the course of the year between the baby's expected date of delivery (zero weeks GCA) and one year GCA. There were two visits, approximately two weeks apart, around zero weeks GCA, six months GCA and one year GCA. One each of the first two sets of meetings was at the SCBU Follow-up Clinic at the Royal Hampshire County Hospital.
The purpose of each pair of visits was to measure the baby, distribute and collect dietary diaries, distribute and explain the appropriate Feeding Guide and discuss any feeding
problems. Additionally, at one of the visits around zero weeks GCA, family background details were collected and other study literature was provided and explained.

2.8.ii. First Clinic Visit
In most instances, the baby and his/her mother were seen in a hospital clinic at zero weeks GCA (term) ± 2 weeks for the first time. At this first visit, the first blood sample was taken by Dr Foote and the weight, length and head circumference of the baby were measured. Details of methods are given in Sections 2.9.i. and 2.10.i. respectively. The mother was given the appropriate milk diary (Appendix VII), an information letter to give to her Health Visitor (Appendix III), and an appointment was made for a visit to the family at home in 10-14 days time. Up to this point, the researcher did not know the baby's group allocation.

2.8.iii. First Home Visit
The following protocol was followed for the first home visit. The baby was weighed and its supine length and head circumference were measured. Each mother was given the First Feeding Guide and a Feeding Record, appropriate to the infant's group assignment. The researcher explained the process of weaning to each mother and went through each section of the First Feeding Guide carefully. The method of completion of the Feeding Record was also discussed and the family background data sheet was completed. The milk diary was collected and briefly checked for correct completion.
Mothers of babies in the intervention group (A) were given the Nutriprem Information Leaflet. The use of Nutriprem as a mixing milk was explained and the order form for the delivery of the formula was completed. Nutriprem was provided free of charge to parents of intervention group infants by Cow & Gate Nutricia.
Parents of each infant in the study were provided with a hardback ring folder with plastic inserts, in which all documents connected with the study could be kept.

2.8.iv. Nutriprem Information Leaflet
After consultation with John Wells, Paediatric Nutrition manager, Cow & Gate Nutricia, an information leaflet on Nutriprem was devised. It detailed the ingredients of the low birth weight milk, instructions for use and the storage instructions. This leaflet was provided to all parents of infants in the intervention group (A) of the study. Appendix IX.
2.8.v. Visits at Six Months GCA
Two visits were made approximately two weeks apart. At both visits the baby was weighed and measured. During the first visit, any feeding difficulties were discussed, the Second Feeding Guide was explained to the parent(s), and food diary completion was explained and demonstrated. The first food diary was collected at the second visit.

2.8.vi. Visits at Twelve Months GCA
Two visits were made approximately two weeks apart. At both visits the baby was weighed and measured. During the first visit, any feeding difficulties were discussed, the Third Feeding Guide was explained to the parent and a check was made to ensure that the parent remembered how to complete the food diary.

At the second visit, which constituted the final study visit, each parent was thanked for participating in the study. In addition, the second food diary was collected at this final visit, together with the Feeding Record.

2.9 Biochemical Analyses

2.9.i. Blood Analysis Protocol
Dr C. James, Haematology Director, Royal Hampshire County Hospital; Dr H. Barbour, Biochemistry Director, Royal Hampshire County Hospital; and Dr H.T. Delves, Trace Element Unit Director, Southampton General Hospital were responsible for haematological, biochemical and trace element analyses, respectively. A Mineral Assay Protocol was drafted and agreed by all concerned parties.

Each blood sample provided a full haematological profile determining haemoglobin, packed cell volume, mean corpuscular haemoglobin concentration and haematocrit. Serum ferritin, serum iron, transferrin, urea, serum zinc, plasma selenium, red blood cell selenium, whole blood selenium, plasma copper and whole blood manganese were also measured. The protocol covered the quantities of blood required for each analysis, the types of tubes required for each sample, the method of sample identification, special precautions associated with sampling and the responsibilities of the analysts and the paediatrician. See 2.9.ii. - 2.9. v.
In the event of blood sample insufficiency from a particular subject, the following priorities were determined. The serum ferritin and serum iron analyses took precedence over the transferrin assay. The zinc and plasma selenium assays took precedence over the red blood cell selenium, copper and manganese analyses.

2.9.ii. Blood Sampling Method

Blood samples (3 ml) were taken by the paediatrician (Dr Foote) at zero weeks GCA and six months GCA. An anaesthetic cream, Ametop, was used to reduce discomfort to the infant. As far as possible, blood testing was performed in conjunction with routine assessment and was subject to parental veto without exclusion from the study. Practical difficulties and ethical objections precluded a third blood sampling at twelve months GCA.

Dr Foote (KF) collected blood, removed by venepuncture from the back of the infant's hand, into three separate tubes. The needle, the gloves, the anaesthetic cream and patches, and the tube for the zinc, selenium, copper and manganese assays, used in each sampling, were taken from study specific equipment, which had been pretested for background zinc content.

All tubes were accompanied by an identifying slip with the infant’s name and date of birth, the abbreviated study title (Weaning Study), Dr Foote’s name and the date of sampling. Samples were taken ideally between Monday and Thursday to allow courier transfer of the tube containing the zinc, selenium, copper and manganese sample, within 24 hours of sampling, to the Trace Element Unit for analysis.

Wherever possible, blood sampling was carried out by KF personally at the Royal Hampshire County Hospital. Occasionally the blood sampling was performed at Andover Memorial Hospital and in one instance at the Princess Anne Hospital, Southampton. For these blood samplings and when KF was absent from duty, KF arranged for a Paediatric Registrar to remove blood, using the study specific equipment and a written protocol for blood sampling. See Appendix X.

Where feasible, all samples were stored until the end of the study. At the study end, all samples were destroyed.

2.9.iii. Haematology Assay

The haemoglobin and haematocrit sample (0.5ml) was collected in an EDTA treated tube. This tube was dispatched to The Haematology Dept., Royal Hampshire County Hospital.
**Haemoglobin:** In an automated process using the Cell Dyn 3000, the blood sample was diluted and lysed to release the haemoglobin, which was converted into a cyanide-containing pigment. The absorbance of the pigment at 540nm was directly proportional to the haemoglobin concentration (Haematology Dept. RHCH, 1998a).

**Haematocrit:** The Cell Dyn analyser also provided the number of red blood cells (RBC) in the sample and the mean cell volume (MCV). The haematocrit (HCT) can be calculated from these according to the formula: HCT = (RBC x MCV)/10 (Haematology Dept. RHCH, 1998a).

**Ferritin:** Ferritin was analysed by the Microparticle Enzyme Immunoassay Technique. The plasma sample was incubated with anti-ferritin alkaline phosphatase conjugate and anti-ferritin coated microparticles to form an antibody-antigen-antibody complex. A fluorescent complex was produced by the addition of 4-methylumbelliferyl phosphate. The rate of production of fluorescence was related to the ferritin present (Haematology Dept. RHCH, 1998b).

2.9.iv. Biochemical Assay

The serum iron, transferrin, urea and ferritin sample (1.0-1.5ml) was collected in a Lithium Heparin tube. This tube was dispatched to The Biochemistry Dept., Royal Hampshire County Hospital. Part of this sample (0.5 ml) was subsequently used in the Haematology Dept. for ferritin analysis.

**Serum Iron Analysis:** The serum iron (Fe$^{3+}$) was separated from transferrin with guanidinium chloride and reduced to Fe$^{2+}$ with ascorbic acid, which was treated with Ferrozine (registered trademark of Hach Chemical Co. Iowa), to form a coloured complex. The colour intensity was measured in a Hitachi 917 machine and was proportional to the iron concentration (The Biochemistry Dept. RHCH, 1998a).

**Transferrin Analysis:** In a buffer solution the sample serum was mixed with human transferrin antiserum. The transferrin in the sample combined with the antiserum to form an antibody-antigen complex. The resulting turbidity was directly proportional to the transferrin concentration and was measured in a Hitachi 917 machine (The Biochemistry Dept. RHCH, 1998b).

**Urea Analysis:** Urea was determined from the amount of NAD$^+$ produced in a two stage kinetic analysis using urease and glutamate dehydrogenase on the serum sample. The NAD$^+$ was measured in a Hitachi 911 machine (The Biochemistry Dept. RHCH, 1998c).
2.9.v. Trace Element Assay

The remainder of the sample (1.0-1.5ml) was collected in a Lithium Heparin tube, pre-tested for zinc content, supplied by Dr H.T. Delves, Trace Element Unit, Clinical Biochemistry, Southampton General Hospital, to whom, the tube was sent for analysis.

*Copper and Zinc:* The plasma copper and zinc were analysed by flame atomic absorption spectrometry, after dilution in 6%v/v aqueous butan-1-ol (Meret & Henkin, 1971).

*Selenium:* Selenium was measured in plasma and in red blood cells by inductively coupled plasma mass spectrometry (Sieniawska et al. 1999). Whole blood selenium concentrations were then calculated using haematocrit values determined as described in Section 2.9.iii.

*Manganese:* Manganese was measured in whole blood by atomic absorption spectrometry using electrothermal atomisation (Shuttler & Delves 1991).

2.10 Anthropometry

2.10.i. Measurement Protocol

Measurements of weight, supine length and head circumference (occipitofrontal) were performed on the infants within two weeks of the gestation corrected ages (GCA) of zero weeks, six months and twelve months. Standardised measurement techniques and equipment were used. The three sets of measurements were made by the researcher. In addition, each infant's weight and length were measured and recorded by the clinic nurse on duty at follow-up clinics attended by all subjects at approximately zero weeks and six months GCA. All measurements were recorded on each infant's growth record (fig. 2.10.i.) and plotted on an individual growth chart.

Wherever possible, the heights and weights of the parents of each infant in the study were recorded to allow an estimation of the infant's growth potential.

The measurement techniques of the researcher were checked by experienced colleagues (Mr E. Wallis-Redworth and Dr J. B. Morgan) before study commencement.

2.10.ii. Weight

Infants were weighed naked using a Seca 834 digital scale, maintained according to manufacturer's instructions, accurate to 10g from 0-10kg and to 20g from 10-20kg. Smaller
infants were weighed in a supine position, older infants, capable of sitting unsupported, were weighed whilst seated in the scales until a constant reading was obtained.

**Figure 2.10.i. Growth Record**

<table>
<thead>
<tr>
<th>Baby’s Name</th>
<th>Code No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.o.B.</td>
<td>Birth Wt.</td>
</tr>
<tr>
<td></td>
<td>EDD</td>
</tr>
</tbody>
</table>

**Dates of First Measurements:**
- **At Home**
- **In Clinic**

- **Weight:**
- **Length:**
- **Head Circumference:**
- **Mid Arm Circumference:**
- **Triceps:**
- **Subscapular:**

**Dates of Second Measurements:**
- **At Home**
- **In Clinic**

- **Weight:**
- **Length:**
- **Head Circumference:**
- **Mid Arm Circumference:**
- **Triceps:**
- **Subscapular:**

**Dates of Third Measurements:**
- **At Home**
- **At Home**

- **Weight:**
- **Length:**
- **Head Circumference:**
- **Mid Arm Circumference:**
- **Triceps:**
- **Subscapular:**

### 2.10.iii. Supine Length

Length was measured using a Harlow Healthcare Rollameter, accurate to 1mm. The infant was measured lying supine on the mat with the top of the head held in contact with the top plate by a parent, whilst the researcher straightened the knees and brought the base plate into
contact with the heels. To improve accuracy, the average of two or three readings was taken whenever possible.

2.10.iv. Head Circumference
The occipitofrontal head circumference was measured using a Harlow Healthcare Lasso-o circumference tape. The measurement from the tape was taken when the tape was positioned midway between the eyebrows and hairline at the front of the infant's head and passing over the occipital prominence at the back.

2.11 Data Analysis

The strictest rules of confidentiality and anonymity were observed in all data handling. All subjects were assigned a code number upon joining the study. All information relating to the subjects was stored, by number only, in a secured personal computer, which was accessed by the researcher only. Hard copies of data were similarly denoted, and stored in a locked cabinet. The clinical collaborator (KF) retained copies of biochemical analyses and growth records required for the continuing clinical management of study infants. Neither the paediatrician (KF) nor the study families were aware of group allocations. The SPSS programme has been used for data storage and statistical analysis. The Diet 5 programme has been used for dietary analysis. The data from the two comparative study groups was analysed by appropriate observational and comparative statistical analysis. The mean values or median values, standard deviations and ranges of values of dietary, biochemical and growth variables have been described. Chi-square and Student's t-tests or non-parametric comparative tests have been used to compare interval means and ranked data for the study groups and genders. Correlations were sought between the growth outcomes and nutritional intakes, specifically the intakes of energy, protein, calcium, iron, zinc, copper and vitamin C. In addition, the relationships between the biochemical variables (iron, zinc, copper and selenium status) and growth were examined. Wherever a positive significant correlation was determined by use of the bivariate correlation facility in SPSS, a scatter plot of the two correlates was plotted to ensure that the association was not spurious.
Repeated Measures ANOVA has been used to explore the effects of group affiliation on variations in growth and dietary intake over time and the interrelationships between growth and dietary variables with time.

Type 1 error probabilities at or below 5% have been judged significant.

Dr A.C. Kimber, Department of Applied Statistics, University of Reading, previously of the University of Surrey has advised.

2.12 Ethics Approval

2.12.i. Main Study

The Comparative Study Protocol, together with an information letter for parents, a letter of consent for parents, a GP information letter and the ethics application form was submitted to the Winchester Local Research Ethics Committee on 11.11.97. The Ethics Committee met on 2.12.97. Permission for the study was initially denied, but after further clarification of the project’s methods, approval was granted informally on 22.12.97. This was confirmed in writing on 27.1.98. See Appendix XI.

2.12. ii. Amendment

An application for an amendment to the Comparative Study was made on 25.9.98 to Winchester Local Research Ethics Committee.

The amendment requested permission to perform two extra analyses on each of the blood samples sent to the Trace Element Unit, Southampton General Hospital. This amendment was requested following advice from Dr Delves, Trace Element Unit. He had informed the researcher that the minerals, manganese and copper, can both be marginal in preterm infants and that the additional assays for copper and manganese could be carried out on the existing samples. The extra analyses would provide more information about the trace element status of preterm infants.

The Chairman of the Ethics Committee approved the amendment subject to ratification by the full committee. This was granted on 20.10.98. See Appendix XI.
2.12.iii. University of Surrey

An application for an endorsement of the approval for the Comparative Study was made to the Advisory Committee on Ethics of the University of Surrey in April 1998. The Advisory Committee approved the study on 26.5.98. See Appendix XI.
CHAPTER 3

RESULTS

3.1. Subjects

3.1. i. Infant Characteristics

Sixty-eight preterm infants were recruited between January 1998 and June 1999. Initially, there were thirty-five boys and thirty-three girls included in the study. Sixty-seven babies were of Caucasian ethnic extraction; the remaining infant was of Asian origin.

Twenty-nine (43%) of the babies were born small-for-gestational age (SGA), i.e. birth weight below the tenth centile for gestational age on the Cross-sectional Stature and Weight Reference Curves for the UK, 1990 (Freeman et al, 1995). Exactly half of the babies weighed less than 1,500g at birth and half weighed 1,500g or more at birth.

Thirty-seven infants were randomised to the intervention group (A) and thirty-one infants to the control group (B). During the study three infants were withdrawn (two group B, one group A), and one infant (group A) was not able to fully comply with the study protocol due to a serious parental health problem. All infants were free from serious pathological conditions at the time of hospital discharge. Two infants were subsequently diagnosed with mild degrees of cerebral palsy. The condition did not impair the feeding ability of either subject during the course of the study.

Seventeen girls and nineteen boys remained in group A and fourteen girls and fifteen boys remained in group B at study end.

The differences between groups in birth weight and gestational age were not significant. The differences in the distribution of the sexes and the proportion of SGA babies between groups were not significant (Tables 3.1.i & ii.).
Male infants had a mean birth weight of 1.43kg (SD 0.44) and a mean gestational age of 31.1 weeks (SD 2.9). Female infants had a mean birth weight of 1.52kg (SD 0.43) and a mean gestational age of 31.7 weeks (SD 2.9). There were no significant differences between the sexes in either birth weight or gestational age at birth.

The birth weight and gestational age characteristics of all the infants and both groups are shown in Tables 3.1.i and 3.1.ii.

### Table 3.1.i. Characteristics of study infants

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Weight (g) - All</td>
<td>68</td>
<td>1472</td>
<td>434</td>
<td>635</td>
<td>2150</td>
</tr>
<tr>
<td>Birth Weight (g) - Group A</td>
<td>37</td>
<td>1454</td>
<td>484</td>
<td>635</td>
<td>2150</td>
</tr>
<tr>
<td>Birth Weight (g) - Group B</td>
<td>31</td>
<td>1493</td>
<td>374</td>
<td>695</td>
<td>2050</td>
</tr>
<tr>
<td>Gestational Age at Birth (weeks) - All</td>
<td>68</td>
<td>31.4</td>
<td>2.9</td>
<td>25</td>
<td>37</td>
</tr>
<tr>
<td>Gestational Age - Group A</td>
<td>37</td>
<td>31.2</td>
<td>2.9</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Gestational Age - Group B</td>
<td>31</td>
<td>31.6</td>
<td>2.9</td>
<td>26</td>
<td>37</td>
</tr>
</tbody>
</table>

### Table 3.1.ii. Characteristics of study groups

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n)</td>
<td>% (n)</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>51 (19)</td>
<td>52 (16)</td>
</tr>
<tr>
<td>Females</td>
<td>49 (18)</td>
<td>48 (15)</td>
</tr>
<tr>
<td>SGA</td>
<td>43 (16)</td>
<td>42 (13)</td>
</tr>
<tr>
<td>AGA</td>
<td>57 (21)</td>
<td>58 (18)</td>
</tr>
</tbody>
</table>

### 3.1.ii. Family Characteristics

One of the families recruited to the study withdrew shortly after recruitment. Hence data concerning the subjects' family characteristics could only be collected from the remaining 67 families. Information relating to parental ages, heights and weights is given in Tables 3.1.iii. and 3.1.iv. Parental characteristics comprise self-reported data.

There were no significant differences in the mean age, weight or height of the parents between study groups. There were no significant differences in the mean age or height of the parents of boys compared with girls. However girls had significantly ($p= 0.004$) heavier fathers (mean = 84.5 kg) compared with boys (mean = 76.2 kg).

Family composition data and smoking prevalence are shown in Table 3.1.v.
More than half of the subjects (60%) were the first child (singleton or twins) born to that family. In the families, smoking rates were lower amongst mothers and approximately the same amongst fathers compared with national rates. For mothers, 15% described themselves as smokers, compared with 26% of new mothers nationally and 29% of the female population in Great Britain (Foster et al, 1997; Office of Population Censuses and Surveys, 1991a). For fathers, 30% described themselves as smokers, compared with 31% of men nationally (Office of Population Censuses and Surveys, 1991a). There were no significant differences in family characteristics between study groups or genders.

Table 3.1.iii. Maternal characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No.</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother's Age (years) at birth of subject</td>
<td>67</td>
<td>30.9</td>
<td>6.5</td>
<td>19.7 - 44.6</td>
</tr>
<tr>
<td>Mother's Height (m)</td>
<td>67</td>
<td>1.65</td>
<td>0.08</td>
<td>1.52 - 1.83</td>
</tr>
<tr>
<td>Mother's Weight (kg) pre-pregnancy</td>
<td>67</td>
<td>62.3</td>
<td>11.6</td>
<td>44.5 - 108</td>
</tr>
</tbody>
</table>

Table 3.1.iv. Paternal characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No.</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father's Age (years) at birth of subject</td>
<td>66</td>
<td>32.9</td>
<td>5.9</td>
<td>21.4 - 48.4</td>
</tr>
<tr>
<td>Father's Height (m)</td>
<td>67</td>
<td>1.78</td>
<td>0.08</td>
<td>1.61 - 1.96</td>
</tr>
<tr>
<td>Father's Weight (kg)</td>
<td>64</td>
<td>80.4</td>
<td>11.7</td>
<td>57.2 - 130.5</td>
</tr>
</tbody>
</table>

Table 3.1.v. Family characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>(No. Included)</th>
<th>%</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Mother</td>
<td>(67)</td>
<td>100</td>
<td>67</td>
</tr>
<tr>
<td>Resident Father</td>
<td>(67)</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>Families with one child only</td>
<td>(67)</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>Families with two children</td>
<td>(67)</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Families with more than two children</td>
<td>(67)</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Multiple Births</td>
<td>(68)</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Mother Smokes</td>
<td>(66)</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Father Smokes</td>
<td>(66)</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Resident Father Smokes</td>
<td>(60)</td>
<td>30</td>
<td>18</td>
</tr>
</tbody>
</table>
3.1.iii. Family Social Class

The social class of each family was determined by comparing the job description of the main family breadwinner (household reference person) with the Standard Occupational Classification (OPCS, 1991b). The range of the social classes represented by study families and a comparison of the study social class distribution with the social class distribution in the UK are shown in Table 3.1.vi and Figure 3.1.i respectively.

Only resident parents were included in the assessment of social class. In the case of families with two full-time employed parents, the parent with the occupation with the higher rated social class was deemed the household reference person.

Table 3.1.vi. Social class distribution in study families

<table>
<thead>
<tr>
<th>Social Class</th>
<th>I</th>
<th>II</th>
<th>IIIN</th>
<th>IIIM</th>
<th>IV</th>
<th>V</th>
<th>Armed Forces</th>
<th>Unclassified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Families (n)</td>
<td>6</td>
<td>22</td>
<td>8</td>
<td>16</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Families (%)</td>
<td>8.8</td>
<td>32.4</td>
<td>11.8</td>
<td>23.5</td>
<td>14.7</td>
<td>4.4</td>
<td>1.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Figure 3.1.i. Social class distribution in study families compared to that in the UK.
The predominant difference in socio-economic demographics between the study families and the general population in the UK was the percentage of families in social class IIIN (12% : 23% respectively).

3.1.iv. Infants' Clinical History

The clinical record sheet completed for each baby from the hospital medical records provided detailed information of the birth details, medical interventions, feeding history and nutritional support received by the infants. The most salient information is summarised in Tables 3.1.vii., 3.1.viii., 3.1.ix. and 3.1.x.

A comprehensive record was unavailable for two infants due to the transfer of the babies between Neonatal Units,

| Table 3.1.vii. Apgar score and weight at discharge of study infants |
|-----------------|-----------|-------|-------|
| Apgar Score at 5 minutes | (n=68) | Median | Min. | Max. |
| Weight at Discharge from N.U. (kg) | (n=66) | 9 | 5 | 10 |
| 2.11 | 1.21 | 3.20 |

| Table 3.1.viii. Clinical interventions in the neonatal unit |
|-----------------|-----------|-------|-----------------|
| Procedure | % | no. | Further Information |
| Ventilation | (n=67) | 39 | 26 | Median vol. = 40ml, Range = 10-101ml |
| Surfactant | (n=66) | 29 | 19 |
| Steroids | (n=66) | 59 | 39 |
| Blood Transfusion | (n=67) | 22 | 15 | Median vol. = 40ml, Range = 10-101ml |
| Oxygen | (n=67) | 58 | 39 | Median no. of days = 5, Range = 1-92 |

The infants' Apgar Scores at five minutes ranged from 5 to 10. There was an almost three-fold variation in the range of infant weights at discharge. However, there were no statistically significant group or gender differences in median Apgar scores or weights at discharge.

There were no significant group or gender differences in the number of infants transfused or given oxygen, surfactant or steroids. More boys than girls were ventilated, 18:8, ($p = 0.02$).

There were no group differences in the relative proportion of infants ventilated:
There were no significant group or gender differences in the volume of blood transfused or the number of days spent receiving oxygen. When ventilated, the girls had a significantly higher mean maximum fractional inspired oxygen concentration (Fi O₂), 0.52 : 0.39, than the boys (p = 0.05).

There were no significant group or gender differences in the incidence of the serious conditions detailed in Table 3.1.ix.

Table 3.1.ix. Clinical conditions which may affect growth /development

<table>
<thead>
<tr>
<th>Condition</th>
<th>%</th>
<th>no.</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraventricular Haemorrhage</td>
<td>(n=68)</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Chronic Lung Disease</td>
<td>(n=68)</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Seizures</td>
<td>(n=68)</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3.1.x. Nutritional support received in the neonatal unit

<table>
<thead>
<tr>
<th>Nutritional Support</th>
<th>%</th>
<th>no.</th>
<th>Further Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Parenteral Nutrition</td>
<td>(n=68)</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>Breast Milk Fortifier</td>
<td>(n=68)</td>
<td>66</td>
<td>45</td>
</tr>
<tr>
<td>Low Birth Weight Formula</td>
<td>(n=68)</td>
<td>91</td>
<td>62</td>
</tr>
</tbody>
</table>

The majority of babies (88%, n=60) were fed a mixture of human milk and one or more types of cow’s milk formula whilst in the unit; a small number (6%, n=4) received only human milk and an equal number (6%) received only infant formula(s). The use of human milk was higher (94%) than the national rate of breast-feeding for low birth weight babies, 63%, (Foster et al., 1997). Over 90% of babies received some low birth weight formula, including those who were breast-fed.

There were no significant group or gender differences in types of milk feeding, the use of total parenteral nutrition or low birth weight formula. A significantly higher number of intervention group babies compared with control group babies (29:16) received breast milk fortifier (BMF), (p = 0.02).

There was no gender difference in BMF use.
3.2. Dietary Analysis of Milk Feeding at Zero Weeks GCA (Term)

3.2.i. Milk Diary Dietary Analysis Difficulties
The majority of baby food manufacturers do not provide information concerning the selenium content of their products. For this reason, no analysis of selenium content of the infants diets was reported at any point in the study.

It was believed when the milk diary for infants receiving some/all human milk was designed and used, that a reasonable estimation of breast milk intake for breast-fed babies could be obtained using time of suckling: weight of milk intake data (Paul et al, 1988; Dewey et al, 1999; Ingram et al, 1999). However, the wide range of intakes/suckling time period from these and similar publications precluded any meaningful interpretation from the diaries completed by breast-feeding mothers.

Therefore the analysis of milk intake at around zero weeks GCA (term) has been determined from the 43 volume intake diaries completed by mothers whose babies received an infant formula milk / bottled expressed breast milk (EBM) as their complete food for one or more days.

3.2.ii. Types of Milk Feeding at Term
At the first study assessment point (median postnatal age = 9.4 weeks) around the expected date of delivery (term), twenty-seven infants (42%) were receiving breast milk, either alone or in combination with an infant formula. This is similar to the national breast-feeding rate, which for 1995 was 38% of babies still receiving some human milk at six to ten weeks of age (Foster et al, 1997). The types of milks consumed by all the infants in the study, the intervention group (A) and control group (B), and those, whose dietary intake was analysed are shown in Table 3.2.i.

For babies receiving some or all non-human milk, fifty-two study infants (91%) were receiving a whey-dominant cow's milk (C.M.) formula, two (3.5%) were receiving a casein-dominant C.M. formula, two (3.5%) were being fed a low birth weight (LBW) formula and one (2%) was being fed a mixture of soya-based formula and whey-dominant formula.

The proportion of whey-dominant : casein-dominant C.M. formula (93%:3.5%) being consumed at this age by study infants is very different from that for all infants aged six to ten weeks in Britain, 37% : 60% (Foster et al, 1997).
The mean weight of the babies at term who were wholly or partially breast-fed was 2.75 kg (SD = 0.58) compared with 3.13 kg (0.48) for wholly bottle-fed babies. This difference in mean weights between bottle and breast fed babies was significant (p<0.001).

### Table 3.2.i. Milk feeding at term

<table>
<thead>
<tr>
<th>Type of Milk</th>
<th>All Babies (n)</th>
<th>Diet Analysed (n)</th>
<th>Group A (n)</th>
<th>Group B (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Milk</td>
<td>12 (8)</td>
<td>0</td>
<td>14 (5)</td>
<td>10 (3)</td>
</tr>
<tr>
<td>Human Milk + C.M. Formula</td>
<td>29 (19)</td>
<td>12 (5)</td>
<td>22 (8)</td>
<td>38 (11)</td>
</tr>
<tr>
<td>Cow's Milk Formula</td>
<td>55 (36)</td>
<td>84 (36)</td>
<td>61 (22)</td>
<td>48 (14)</td>
</tr>
<tr>
<td>Soya-based + C.M. Formula</td>
<td>2(1)</td>
<td>2(1)</td>
<td>0</td>
<td>3(1)</td>
</tr>
<tr>
<td>LBW Formula only</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>3 (1)</td>
<td>0</td>
</tr>
</tbody>
</table>

There were no significant differences for groups or genders in the type of milk feeding received by the babies, whether all babies in the study were included in the analysis or only those whose diets were analysed.

### 3.2.iii. Energy & Macronutrient Intake of All Infants

The total daily energy and macronutrient intakes together with the values/kg body weight/day at term for all babies (n = 43) included in the analysis are given in Table 3.2.ii.

### Table 3.2.ii. Energy & macronutrient intakes & intake/kg at term - all included infants

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>kj (kcal)</td>
<td>1816 (434)</td>
<td>400 (96)</td>
<td>1150-3120 (275-746)</td>
</tr>
<tr>
<td>Energy/kg</td>
<td>kj (kcal)</td>
<td>585 (140)</td>
<td>125 (30)</td>
<td>372-988 (89-236)</td>
</tr>
<tr>
<td>Protein</td>
<td>g</td>
<td>9.7</td>
<td>2.2</td>
<td>5.9-16.7</td>
</tr>
<tr>
<td>Protein/kg</td>
<td>g</td>
<td>2.7</td>
<td>0.6</td>
<td>2.0-4.7</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>g</td>
<td>46.8</td>
<td>10.4</td>
<td>9.6-80.2</td>
</tr>
<tr>
<td>Carbohydrate/kg</td>
<td>g</td>
<td>15.1</td>
<td>3.4</td>
<td>9.6-27.3</td>
</tr>
<tr>
<td>Fat</td>
<td>g</td>
<td>23.3</td>
<td>5.1</td>
<td>14.8-40.1</td>
</tr>
<tr>
<td>Fat/kg</td>
<td>g</td>
<td>7.5</td>
<td>1.6</td>
<td>4.8-12.3</td>
</tr>
<tr>
<td>Protein Energy Ratio</td>
<td>%</td>
<td>8.9</td>
<td>0.5</td>
<td>7.2-10.4</td>
</tr>
</tbody>
</table>
The infants had a mean (SD) postnatal age of 9.5 (3.3) weeks and a mean gestation corrected age of 1.1 (1.3) weeks at diary completion. There were no significant differences in the mean postnatal ages or GCA of infants in the two groups.

The percentage contributions of protein, fat and carbohydrate to energy were 9% : 48% : 43%, respectively. The range of intakes of energy and macronutrients was large, reflecting the wide variation in milk intake volumes. This variance was maintained when intake/kg body weight was considered.

There were no significant group or gender differences in mean daily intakes of energy or macronutrients at term.

3.2.iv. Specified Mineral & Vitamin Intakes of All Infants

The intake ranges of the vitamins and minerals from milk intake at term were similarly wide. The analyses of the micronutrients of interest to the study are shown in Table 3.2.iii.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>mg</td>
<td>109</td>
<td>30</td>
<td>66-193</td>
</tr>
<tr>
<td>Sodium/kg</td>
<td>mg</td>
<td>35</td>
<td>10</td>
<td>21-72</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>304</td>
<td>74</td>
<td>162-513</td>
</tr>
<tr>
<td>Calcium/kg</td>
<td>mg</td>
<td>98</td>
<td>23</td>
<td>56-165</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg</td>
<td>209</td>
<td>57.4</td>
<td>73-379</td>
</tr>
<tr>
<td>Phosphorus/kg</td>
<td>mg</td>
<td>67</td>
<td>17</td>
<td>25-111</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>9.2</td>
<td>2.2</td>
<td>5.1-16.7</td>
</tr>
<tr>
<td>Iron/kg</td>
<td>mg</td>
<td>3.0</td>
<td>0.9</td>
<td>1.3-6.6</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>3.8</td>
<td>1.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Zinc/kg</td>
<td>mg</td>
<td>1.2</td>
<td>0.3</td>
<td>0.5-1.9</td>
</tr>
<tr>
<td>Copper</td>
<td>µg</td>
<td>206</td>
<td>56</td>
<td>120-440</td>
</tr>
<tr>
<td>Copper/kg</td>
<td>µg</td>
<td>67</td>
<td>20</td>
<td>40-160</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>µg</td>
<td>1690</td>
<td>116</td>
<td>1488-2036</td>
</tr>
<tr>
<td>Vitamin A/kg</td>
<td>µg</td>
<td>549</td>
<td>73</td>
<td>424-708</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>107</td>
<td>14</td>
<td>70-150</td>
</tr>
<tr>
<td>Vitamin C/kg</td>
<td>mg</td>
<td>35</td>
<td>6</td>
<td>24-51</td>
</tr>
</tbody>
</table>
The calcium: phosphorus molar ratio was 1.1 : 1.

There were no significant group or gender differences in mean daily intakes of the specified vitamins and minerals.

3.2.v. Comparison of All Study Infants' Intakes with Recommendations

A comparison of the infants' mean daily intakes with the Tsang Recommendations for Stable Growing Preterm Infants (Appendix I) indicated that per kg body weight the study infants were consuming more energy, iron, zinc and vitamin C and very much more vitamin A, but less protein, sodium, calcium and copper, on average, than the recommended daily intakes.

A comparison with the Dietary Reference Values (Appendix I) for full-term infants shortly after birth demonstrated a similar pattern, except that the mean daily phosphorus intake appeared deficient when compared with the recommended nutrient intake (RNI) and the mean daily zinc intake was lower than the RNI.

3.2.vi. Supplement Usage at Term

The reported use of supplements at term for the 65 babies, whose parent(s) completed a milk diary, is shown in Table 3.2.iv. All the study infants were prescribed a multivitamin supplement (usual dose = 0.6ml/day); babies weighing less than 2kg at birth (n=62) were routinely prescribed iron (usual dose = 5mg/day) and folic acid (usual dose = 100µg/day).

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Commercial Name</th>
<th>All Babies</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivitamin</td>
<td>Abidec</td>
<td>100</td>
<td>66</td>
<td>100</td>
</tr>
<tr>
<td>Iron</td>
<td>Sytron</td>
<td>88</td>
<td>58</td>
<td>84</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>-</td>
<td>89</td>
<td>59</td>
<td>87</td>
</tr>
</tbody>
</table>

There was full reported compliance (100%) with vitamin supplement prescription. The differences in supplement usage between groups and genders were not significant.
3.3. Age at First Introduction of Solid Foods

3.3.1. First Solid Food Choices - All Infants

An analysis of the Feeding Records (figure 2.7.i.), showed that in all cases the first solid food introduced was a gluten-free cereal mixed with baby milk (Nutriprem, human milk or the baby's regular milk formula). The range of postnatal ages at which weaning began was wide, varying between 2.5 to 6 months (0.5. to 4.1 months GCA).

The mean postnatal ages, standard deviations and range of ages for the age at introduction of the different types of food, i.e. cereals, vegetables, fruit, cheese and meat are shown in Table 3.3.i. The mean (SD) gestation corrected ages are also included in Table 3.3.i.

There was a significant correlation between gestational age at birth and postnatal age at first solid food introduction for infants born before 36 weeks gestation. See figure 3.3.i.

A minority of mothers (three, 6%) introduced all the different types of food, i.e. cereals, vegetables, fruit, cheese and meat, within two weeks of the introduction of the first solid food. The more usual interval, mean (SD), between the introduction of a new type of food after the introduction of the first cereal food was 2.7 (4.6) weeks for vegetable, 3.5 (3.0) weeks for fruit, 7.8 (5.3) weeks for cheese, and 8.0 (4.6) weeks between cereal and meat. These mean time intervals correspond with the time interval recommendations suggested in the Feeding Guidelines (Appendices V & VI).

One baby was fed a vegetarian diet and received no meat for the duration of the study. Two babies were believed to be cow's milk intolerant and received no cow's milk products for the duration of the study.

Table 3.3.i. Infants' mean ages at different types of solid food introduction - all infants

<table>
<thead>
<tr>
<th>Type of Food</th>
<th>Postnatal Age (weeks)</th>
<th>GCA (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
<td>16.3</td>
<td>8.0 (3.8)</td>
</tr>
<tr>
<td>Vegetable</td>
<td>18.9</td>
<td>10.5 (4.5)</td>
</tr>
<tr>
<td>Fruit</td>
<td>20.0</td>
<td>11.5 (3.6)</td>
</tr>
<tr>
<td>Cheese</td>
<td>23.5</td>
<td>15.0 (4.5)</td>
</tr>
<tr>
<td>Meat</td>
<td>24.4</td>
<td>15.8 (5.9)</td>
</tr>
</tbody>
</table>
The babies who were still receiving breast milk at six months GCA were introduced to solids at a later mean postnatal age (17.7 weeks) than those who were fully formula fed (16.1 weeks) at this stage, but the difference in mean ages was not significant.

### 3.3.ii. First Solid Food Introduction for Study Groups

The mean postnatal (pn) and gestation corrected ages and standard deviations for the age at introduction of the different types of food specified above for the intervention group (A) and control group (B) are shown in Table 3.3.ii.

The order of introduction for different types of foods for Group A was cereals, vegetables, fruit, cheese and meat. This corresponded with the recommendations in the First Feeding Guide for the intervention group (A), (Appendix V). The order of introduction for different types of foods for Group B was cereals, fruit, vegetables, cheese and meat, which corresponded with the recommendations in the First Feeding Guide for the control group (B), (Appendix VI).
The mean postnatal age for the introduction of the first solid food was significantly earlier for the intervention group babies (14.9 weeks) compared with the control group babies (17.8 weeks). Vegetables, cheese and meat were also introduced earlier by intervention group parents, though only the introduction of vegetables was at a significantly earlier postnatal age for group A babies compared with group B babies (17.8:20.0 weeks).

### Table 3.3.i. Mean ages for groups A & B at solid food introduction

<table>
<thead>
<tr>
<th>Type of Food</th>
<th>Group A (n=29)</th>
<th>Group B (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean pn age (SD) weeks</td>
<td>GCA (SD) weeks</td>
</tr>
<tr>
<td>Cereal</td>
<td>14.9 ^a (3.0)</td>
<td>6.3 ^c (3.0)</td>
</tr>
<tr>
<td>Vegetable</td>
<td>17.8 ^b (3.2)</td>
<td>9.0 ^d (2.9)</td>
</tr>
<tr>
<td>Fruit</td>
<td>20.2 (3.7)</td>
<td>11.3 (3.5)</td>
</tr>
<tr>
<td>Cheese</td>
<td>22.8 (4.4)</td>
<td>13.9 (4.3)</td>
</tr>
<tr>
<td>Meat</td>
<td>23.3 (4.8)</td>
<td>14.3 (4.8)</td>
</tr>
</tbody>
</table>

^a p = 0.003, ^b p = 0.03, ^c p = 0.001, ^d p = 0.002; A vs B.

There were no significant gender differences in the mean postnatal or gestation corrected age at introduction of the five food types specified.

### 3.3.iii. First Solid Food Choices

The most frequently chosen first foods in the cereal, vegetable, fruit and meat categories are ranked in Table 3.3.iii. As the first type of cheese introduced to each baby was rarely specified, no analysis could be performed for first type of cheese offered.

The four most frequently chosen vegetable meals for both groups are illustrated in Figure 3.3.ii.

Intervention group parents chose Baby Rice, Farex or Rusk for their baby's first cereal, in line with Feeding Guide recommendations. However, statistically, there were no significant differences in the choice of first foods in the cereal, fruit or meat categories for groups or sexes. The choice of first vegetable meal was significantly different for the intervention group compared with the control group (p = 0.001).

The differences between first vegetable choices for the two groups were in accordance with the recommendations in the appropriate First Feeding Guide (Appendices V & VI). The First Feeding Guide for the intervention group stipulated potato or potato + small amount of
another vegetable or a choice from the specified list of commercial mixed vegetable meals, whereas the control group recommendations did not specify potato as the first vegetable choice.

Table 3.3.iii. First choice for different types of solid food- all infants

<table>
<thead>
<tr>
<th>First Cereals</th>
<th>% (n)</th>
<th>First Vegetables % (n)</th>
<th>First Fruits % (n)</th>
<th>First Meats % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>84 (46)</td>
<td>Potato 30 (16)</td>
<td>Banana 43 (23)</td>
<td>Chicken 62 (31)</td>
</tr>
<tr>
<td>Farex</td>
<td>5 (3)</td>
<td>Mixed Vegetables 30 (16)</td>
<td>Apple 21 (11)</td>
<td>Turkey 16 (8)</td>
</tr>
<tr>
<td>Rusk</td>
<td>5 (3)</td>
<td>Potato + other Vegetable(s) 21 (11)</td>
<td>Mixed Fruit 11 (6)</td>
<td>Lamb 10 (5)</td>
</tr>
<tr>
<td>Oat Porridge</td>
<td>4 (2)</td>
<td>Carrot 19 (10)</td>
<td>Orange 9 (5)</td>
<td>Beef 6 (3)</td>
</tr>
<tr>
<td>Mixed Cereals</td>
<td>2(1)</td>
<td>-</td>
<td>Other 15 (8)</td>
<td>Pork 6 (3)</td>
</tr>
</tbody>
</table>

Fig. 3.3.ii. First choice of vegetable for intervention and control group
3.4. Dietary Analysis of Milk and Solid Feeding at Six Months GCA

3.4.i. First Food Diary Dietary Analysis Difficulties
The difficulty of estimating breast milk intake with an acceptable degree of accuracy precluded the diaries of babies receiving breast milk as their only or substantial form of milk (5 diaries) from the dietary analysis of the first food diaries (see Section 3.2.i.). In addition, one diary was mislaid, two mothers did not complete diaries and one diary was removed from the analysis due to inaccurate reporting. Consequently, only 56 diaries have been included in the analysis, including two diaries containing small amounts of human milk. Human milk intake was estimated using the conversion method for suckling time to weight of intake (Paul et al., 1988).

The reported results include only those nutrients which the researcher was confident were fully disclosed on nutrient composition analyses of the commercial baby foods used by study parents.

3.4.ii. Types of Milk Feeding
At six months gestation corrected age (median postnatal age = 34.7 weeks) 11% (n=7) of infants were receiving human milk. The national rate of breast-feeding for all infants was 14% in 1995 for babies aged nine months (Foster et al., 1997). Four babies were receiving human milk as their only milk drink, one was predominantly breast-fed and two received a mixture of formula and human milks. The remaining 89% (n=55) were given an infant formula as their only milk drink. The types of milk received by study babies at six months GCA are shown in Table 3.4.i.

The mean weight (SD) at six months GCA of the formula fed infants was 7.25 (0.99) kg. These babies were significantly heavier ($p = 0.001$) than the seven babies who were wholly or partially breast-fed, mean weight 6.68 (0.72) kg. There were no significant group or gender differences in weight at this point.

For the 58 babies who received any infant formula at six months GCA, 43% (n=25) of babies received a standard cow's milk formula, 53% (n=31) of babies received a follow-on formula alone or in combination with another milk and 3% (n=2) were given a soya formula. There were no significant differences in the pattern of milk feeding between groups or genders.
Table 3.4.i. Milk feeding at six months GCA

<table>
<thead>
<tr>
<th>Type of Milk</th>
<th>All (n=62) %</th>
<th>Group A (n=34) %</th>
<th>Group B (n=28) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast milk only</td>
<td>6 (4)</td>
<td>3 (1)</td>
<td>11 (3)</td>
</tr>
<tr>
<td>Breast milk + formula</td>
<td>5 (3)</td>
<td>6 (2)</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Whey dominant formula</td>
<td>15 (9)</td>
<td>15 (5)</td>
<td>14 (4)</td>
</tr>
<tr>
<td>Casein dominant formula</td>
<td>24 (15)</td>
<td>21 (7)</td>
<td>29 (8)</td>
</tr>
<tr>
<td>Follow-on formula</td>
<td>36 (22)</td>
<td>41 (14)</td>
<td>29 (8)</td>
</tr>
<tr>
<td>Standard + Follow-on formula</td>
<td>11 (7)</td>
<td>12 (4)</td>
<td>11 (3)</td>
</tr>
<tr>
<td>Soya formula</td>
<td>3 (2)</td>
<td>3 (1)</td>
<td>4 (1)</td>
</tr>
</tbody>
</table>

3.4.iii. Energy and Macronutrient Intakes for All Infants at Six Months GCA

The analysis of 7-day, weighed intake food diaries completed at six months GCA is shown in Table 3.4.ii. and Table 3.4.iii. for the 56 babies who received infant formula milk as their main milk drink. The infants had a mean (SD) postnatal age of 34.7 (3.5) weeks and a mean gestation corrected age of 26.3 (1.4) weeks at diary completion. Mean daily total energy, mean daily total nutrient intake and intake ranges are shown together with mean intakes/kg body weight/day and range/kg of body weight/day.

Table 3.4.ii. Energy & macronutrient intake & intake/kg at 6 mo. GCA- all included infants

<table>
<thead>
<tr>
<th>Macronutrient</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>kj(kcal)</td>
<td>3273 (782)</td>
<td>570 (136)</td>
<td>2364-4753 (565-1136)</td>
</tr>
<tr>
<td>Energy/kg</td>
<td>kj(kcal)</td>
<td>459 (110)</td>
<td>93 (22)</td>
<td>305-735 (73-176)</td>
</tr>
<tr>
<td>Protein</td>
<td>g.</td>
<td>25.1</td>
<td>6.9</td>
<td>13.2-48.1</td>
</tr>
<tr>
<td>Protein/kg</td>
<td>g.</td>
<td>3.5</td>
<td>1.0</td>
<td>1.8-6.8</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>g.</td>
<td>101.9</td>
<td>20.8</td>
<td>69.5-167.2</td>
</tr>
<tr>
<td>Carbohydrate/kg</td>
<td>g.</td>
<td>14.3</td>
<td>3.4</td>
<td>9.0-26.0</td>
</tr>
<tr>
<td>Fat</td>
<td>g.</td>
<td>31.3</td>
<td>5.1</td>
<td>21.5-42.4</td>
</tr>
<tr>
<td>Fat/kg</td>
<td>g.</td>
<td>4.4</td>
<td>0.8</td>
<td>2.9-7.1</td>
</tr>
<tr>
<td>Protein Energy Ratio</td>
<td>%</td>
<td>12.7</td>
<td>2.2</td>
<td>8.8-18.7</td>
</tr>
</tbody>
</table>
The daily ranges of energy intake and macronutrient intakes were large and the variations did not diminish when intakes/kg of body weight/day were calculated.

Overall in the infants' diets, the mean percentage contributions of protein, fat and carbohydrate to energy were 13 : 37 : 50, respectively. This distribution represents a significant 23% decrease in the contribution of mean energy from fat to dietary energy (\( p = 0.001 \)) between term and six months GCA, with proportionately more energy provided by protein and carbohydrate in infant diets. See fig. 3.4.i.

The mean PER increased from 8.9% at term to 12.7% at six months GCA (\( p = 0.001 \)).

**Fig. 3.4.i.** Protein energy to total energy intake at six months GCA - all infants

Compared with the daily dietary intake around term, the mean energy intake/kg body weight decreased significantly from 585kj to 459kj (\( p = 0.001 \)). The changes in mean daily protein intake/kg body weight from 2.7g to 3.5 g and fat intake/kg body weight from 7.5g to 4.4g were significant (\( p = 0.001 \) & 0.001), whereas the small decrease in mean daily carbohydrate intake/kg body weight from 15.1 to 14.3g was not significant.
3.4.iv. Intakes of Minerals & Vitamin C for All Infants at Six Months GCA

Only micronutrients of particular interest to the study were included in the analysis.

There was a unimolar ratio of calcium to phosphorus at this assessment point.

Table 3.4.iii. Mineral & vitamin C intakes & intake/kg at 6 months GCA- all included infants

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>mg</td>
<td>415</td>
<td>210</td>
<td>191-1554</td>
</tr>
<tr>
<td>Sodium/kg</td>
<td>mg</td>
<td>58</td>
<td>30</td>
<td>26-219</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>714</td>
<td>191</td>
<td>352-1215</td>
</tr>
<tr>
<td>Calcium/kg</td>
<td>mg</td>
<td>100</td>
<td>29</td>
<td>52-200</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg</td>
<td>552</td>
<td>188</td>
<td>285-1297</td>
</tr>
<tr>
<td>Phosphorus/kg</td>
<td>mg</td>
<td>76</td>
<td>27</td>
<td>38-183</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>12.7</td>
<td>4.1</td>
<td>5.9-26.9</td>
</tr>
<tr>
<td>Iron/kg</td>
<td>mg</td>
<td>1.8</td>
<td>0.7</td>
<td>0.8-4.2</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>5.5</td>
<td>1.3</td>
<td>2.9-9.0</td>
</tr>
<tr>
<td>Zinc/kg</td>
<td>mg</td>
<td>0.8</td>
<td>0.2</td>
<td>0.4-1.5</td>
</tr>
<tr>
<td>Copper</td>
<td>µg</td>
<td>456</td>
<td>171</td>
<td>130-950</td>
</tr>
<tr>
<td>Copper/kg</td>
<td>µg</td>
<td>64</td>
<td>24</td>
<td>20-130</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>131</td>
<td>52</td>
<td>55-404</td>
</tr>
<tr>
<td>Vitamin C/kg</td>
<td>mg</td>
<td>18</td>
<td>8</td>
<td>10-59</td>
</tr>
</tbody>
</table>

3.4.v. Comparison of Infants' Intakes with Recommendations

A comparison of the infant's mean daily intakes with the Dietary Reference Values (Appendix I) for full-term infants aged six to nine months indicated that the study babies were consuming more energy than the estimated average requirement and that their mean daily intake of protein, sodium, calcium, phosphorus, iron, zinc, copper and vitamin C intakes exceeded the recommended nutrient intakes (RNI).

A comparison of the infants' mean daily intakes with the Tsang Recommendations for Stable Growing Preterm Infants (Appendix I) indicated that per kg body weight/day the study infants were consuming amounts of energy, protein, sodium, iron, phosphorus and vitamin C broadly equivalent to the recommendations but less calcium, zinc and copper than the recommended intakes.
3.4.vi. Supplement Usage

The reported use of supplements at six months GCA for the 61 babies, whose parent(s) completed the relevant section of the food diary, is shown in Table 3.4.iv., together with supplement usage for formula fed babies and the intervention (A) and control (B) groups. The pattern for supplement usage in breast-fed and formula-fed babies was very similar. More group B infants were still taking non supplements at six months post-term than group A infants, the differences in iron and vitamin supplementation between groups were not significant. The gender difference in uptake of supplements was not significant.

Table 3.4.iv. Vitamin & mineral supplement usage at six months GCA

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Usage (all babies) (n= 61)</th>
<th>Usage(formula-fed) (n= 56)</th>
<th>Group A (n= 33)</th>
<th>Group B (n= 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Multivitamin</td>
<td>54</td>
<td>33</td>
<td>57</td>
<td>32</td>
</tr>
<tr>
<td>Iron</td>
<td>34</td>
<td>21</td>
<td>34</td>
<td>19</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>23</td>
<td>14</td>
<td>25</td>
<td>14</td>
</tr>
</tbody>
</table>

3.4.vii. Energy and Nutrient Intakes for the Intervention (A) and Control (B) Groups

A comparison of the intakes of the specified nutrients and energy by the intervention and control groups is shown Table 3.4.v. There were no significant differences in the mean postnatal ages or GCA of infants in the two groups.

Mean intakes of energy, protein and carbohydrate were significantly higher for the intervention group compared with the control group. The mean protein energy ratio (PER) was higher for the intervention group (12.9%) than for the control group (12.5%) and the intervention group achieved a higher intake of the other specified nutrients but these differences were not significant. The iron intake was higher for group A compared with group B, even though a smaller number of babies were being iron supplemented (24% : 46%). However, mean intakes of iron and vitamin C were significantly higher for babies who were given vitamin/mineral supplements, 15.5 vs 10.6 mg ($p = 0.001$) and 145 vs 105 mg ($p = 0.003$), respectively.

There were no significant gender differences in intakes of the specified nutrients.
Table 3.4.v. Energy & nutrient intakes at six months GCA- groups A & B

<table>
<thead>
<tr>
<th>Unit</th>
<th>Group A (n= 32)</th>
<th>Group B (n= 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Energy</td>
<td>kj(kcal)</td>
<td>3442 (823)</td>
</tr>
<tr>
<td>Protein</td>
<td>g.</td>
<td>26.7 b</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>g.</td>
<td>108.3 c</td>
</tr>
<tr>
<td>Fat</td>
<td>g.</td>
<td>32.3</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg</td>
<td>436</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>751</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg</td>
<td>561</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>12.9</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>5.6</td>
</tr>
<tr>
<td>Copper</td>
<td>µg</td>
<td>481</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>133</td>
</tr>
</tbody>
</table>

*p = 0.009, *b p = 0.04, *c p = 0.007; intervention vs. control.

3.5. Dietary Analysis of Milk and Solid Feeding at Twelve Months GCA

3.5.i. Second Food Diary Dietary Analysis Difficulties
One baby was receiving human milk as her only source of milk at one year GCA. The dietary intake data for this infant was excluded from the energy and nutrient analysis for the reason elucidated in 3.2.i. Two mothers did not complete diaries. Three diaries were eliminated from the energy and nutrient analysis due to grossly inaccurate reporting.

The reported results include only those nutrients which the researcher was confident were fully disclosed on nutrient composition analyses of the commercial baby foods used by study parents.

3.5.ii. Types of Milk Feeding
At twelve months GCA, one infant (1.6%) out of 65 was receiving human milk. The pattern of milk feeding for the infants whose parent(s) completed the milk feeding section of a food diary (n=62) is shown in Table 3.5.i.
Of the 59 babies whose diaries were included in the dietary analysis, 56% (n= 33) had already been changed to full fat cow's milk by twelve months GCA. The majority of the remainder, 32% (n=19), were receiving a follow-on formula as their milk drink. There was a significant difference \( (p = 0.04) \) in the pattern of milk feeding between groups. More intervention group babies were receiving follow-on formula rather than full fat cow's milk whereas the reverse was true for control group babies.

**Table 3.5.i. Milk feeding at twelve months GCA**

<table>
<thead>
<tr>
<th>Type of Milk</th>
<th>All (n= 62)</th>
<th>Group A (n=34)</th>
<th>Group B (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% (n)</td>
<td>% (n)</td>
<td>% (n)</td>
</tr>
<tr>
<td>Breast milk only</td>
<td>2 (1)</td>
<td>3 (1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Standard formula</td>
<td>10 (6)</td>
<td>12 (4)</td>
<td>7 (2)</td>
</tr>
<tr>
<td>Follow-on formula</td>
<td>31 (19)</td>
<td>44(^a) (15)</td>
<td>18 (5)</td>
</tr>
<tr>
<td>Cow's milk</td>
<td>54 (33)</td>
<td>38 (13)</td>
<td>71(^b) (20)</td>
</tr>
<tr>
<td>Soya formula</td>
<td>3 (2)</td>
<td>3 (1)</td>
<td>4 (1)</td>
</tr>
</tbody>
</table>

\(^a\) \(p = 0.04\), \(^b\) \(p = 0.04\); intervention vs. control

**3.5.iii. Energy and Macronutrient Intakes at Twelve Months GCA - All Infants**

The analysis of 7-day, weighed intake food diaries completed at twelve months GCA is shown in Table 3.5.ii. and Table 3.5.iii. for 59 babies all of whom received an infant formula milk or cow's milk as their main milk drink. Mean total energy, mean total nutrient intake and intake range are shown together with mean intakes/kg and range/kg of the infant's body weight. The infants had a mean (SD) postnatal age of 60.8 (3.1) weeks and a mean gestation corrected age of 52.2 (1.0) weeks at diary completion.

The ranges of energy intake and macronutrient intakes were large and the variations did not diminish when intake/kg of body weight were calculated.

The percentage contributions of protein, fat and carbohydrate to energy were 15 : 37 : 48, respectively. This distribution represents a small (non significant) mean (2%) decrease in the contribution of energy from dietary carbohydrate between six months GCA and twelve months GCA, with a corresponding increase in energy from protein. The percentage of energy from fat remained unchanged in infant diets between six months GCA and twelve months GCA. The distribution of percentage of energy from protein compared with total energy for all the children is illustrated in figure 3.5.i. The mean PER increased from 12.7% at six months GCA to 15% at twelve months GCA \( (p = 0.001) \).
### Table 3.5.ii. Energy & macronutrient intake & intake/kg at twelve months GCA-all infants

<table>
<thead>
<tr>
<th>Macronutrient</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>kj(kcal)</td>
<td>4162 (996)</td>
<td>996 (238)</td>
<td>2765-6699 (655-1603)</td>
</tr>
<tr>
<td>Energy/kg</td>
<td>kj(kcal)</td>
<td>459 (110)</td>
<td>132 (32)</td>
<td>285-923 (68-221)</td>
</tr>
<tr>
<td>Protein</td>
<td>g.</td>
<td>37.3</td>
<td>10.0</td>
<td>17.9-63.7</td>
</tr>
<tr>
<td>Protein/kg</td>
<td>g.</td>
<td>4.1</td>
<td>1.2</td>
<td>2.2-7.9</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>g.</td>
<td>123.7</td>
<td>33.1</td>
<td>69.5-206.2</td>
</tr>
<tr>
<td>Carbohydrate/kg</td>
<td>g.</td>
<td>13.6</td>
<td>4.2</td>
<td>6.4-27.5</td>
</tr>
<tr>
<td>Fat</td>
<td>g.</td>
<td>41.3</td>
<td>10.6</td>
<td>23.7-75.7</td>
</tr>
<tr>
<td>Fat/kg</td>
<td>g.</td>
<td>4.6</td>
<td>1.4</td>
<td>2.9-9.4</td>
</tr>
<tr>
<td>Protein Energy Ratio</td>
<td>%</td>
<td>15.0</td>
<td>2.1</td>
<td>9.1-19.4</td>
</tr>
</tbody>
</table>

**Fig. 3.5.i. Protein energy ratio at twelve months GCA**

Median PER = 14.9.

The decreases in mean daily fat intake/kg of body weight, from 7.5g to 4.6g and mean daily carbohydrate intake/kg of body weight, from 15.1g to 13.6g, over the year were significant \( p \)
= 0.001 & 0.01, respectively). The changes in mean daily fat and carbohydrate intakes/kg of body weight from six months GCA to twelve months GCA were not significant. Compared with mean daily energy intake around term, the mean energy intake/kg body weight decreased from 585kj to 459kj ($p = 0.001$); this was unchanged since six months GCA. The mean daily protein intake/kg body weight increased significantly from 2.7g to 4.1g between term and twelve months GCA ($p = 0.001$). This represents a further mean increase of 0.6 g/kg of body weight since six months GCA ($p = 0.001$).

3.5.iv. Mineral & Vitamin C Intakes at Twelve Months GCA - All Infants

The specified mineral and vitamin C daily intakes and the daily intakes/kg body weight are shown in Table 3.5.iii.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>mg</td>
<td>1035</td>
<td>458</td>
<td>362-2305</td>
</tr>
<tr>
<td>Sodium/kg</td>
<td>mg</td>
<td>113</td>
<td>51</td>
<td>43-257</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>824</td>
<td>218</td>
<td>416-1276</td>
</tr>
<tr>
<td>Calcium/kg</td>
<td>mg</td>
<td>91</td>
<td>28</td>
<td>50-182</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg</td>
<td>805</td>
<td>213</td>
<td>425-1265</td>
</tr>
<tr>
<td>Phosphorus/kg</td>
<td>mg</td>
<td>88.6</td>
<td>26.8</td>
<td>47.2-179.9</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>8.1</td>
<td>4.7</td>
<td>2.8-23.2</td>
</tr>
<tr>
<td>Iron/kg</td>
<td>mg</td>
<td>0.9</td>
<td>0.5</td>
<td>0.3-2.6</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>5.3</td>
<td>1.6</td>
<td>3.0-10.8</td>
</tr>
<tr>
<td>Zinc/kg</td>
<td>mg</td>
<td>0.6</td>
<td>0.2</td>
<td>0.3-1.3</td>
</tr>
<tr>
<td>Copper</td>
<td>µg</td>
<td>395</td>
<td>290</td>
<td>100-225</td>
</tr>
<tr>
<td>Copper/kg</td>
<td>µg</td>
<td>43</td>
<td>33</td>
<td>10-250</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>78.9</td>
<td>40.3</td>
<td>14.9-168.3</td>
</tr>
<tr>
<td>Vitamin C/kg</td>
<td>mg</td>
<td>8.8</td>
<td>4.7</td>
<td>1.8-19.8</td>
</tr>
</tbody>
</table>

The mean Calcium: Phosphorus molar ratio was 1 : 1.2 at twelve months GCA.

The mean daily intake of sodium/kg body weight increased from 35mg to 113mg ($p = 0.001$) between term and twelve months GCA. Similarly, the mean daily intake of phosphorus/kg
body weight increased from 67mg to 89mg (p = 0.001) between term and twelve months GCA.
The mean daily intakes of all other specified minerals/kg body weight and vitamin C/kg body weight decreased over the course of the study. Mean daily calcium/kg body weight decreased from 98mg to 91mg (p = 0.05), iron from 3.0mg to 0.9mg (p = 0.001), copper from 67μg to 43μg (p = 0.001), and vitamin C from 35mg to 8.8mg (p = 0.001), over the course of the study.

3.5.v. Comparison of Infants' Intakes with Recommendations
A comparison with the Dietary Reference Values (Appendix I) for full-term infants aged around one year indicated that the study babies were consuming slightly more energy (mean daily intake) than the estimated average requirement, that their mean daily protein, sodium, calcium, phosphorus, and vitamin C intakes greatly exceeded the recommended nutrient intakes (RNI) and that their iron, zinc and copper intakes were approximately equivalent to the RNI.

3.5.vi. Supplement Usage
The reported use of supplements at twelve months GCA for the 61 babies, whose parent(s) supplied the relevant information, is shown in Table 3.5.iv., together with supplement usage for the intervention (A) and control (B) groups.
Most parents were advised by their child's paediatrician, general practitioner or health visitor that vitamin and mineral supplements were no longer necessary after six months GCA. Hence, there was a marked decline in supplement usage between six months GCA and twelve months GCA.

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Usage (n= 61)</th>
<th>Group A (n= 33)</th>
<th>Group B (n= 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Multivitamin</td>
<td>23</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>Iron</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

The group and gender differences in the uptake of supplements were not significant.
3.5.vii. Energy and Nutrient Intakes for the Intervention (A) and Control (B) Groups

A comparison of the intakes of the specified nutrients and energy by the intervention and control groups is shown Table 3.5.v. There were no significant differences in the mean postnatal ages or GCA of infants in the two groups.

The dietary intakes were less group differentiated at twelve months GCA than at six months GCA. This may reflect a convergence in feeding practices between groups towards the end of the study. Mean intakes of energy, carbohydrate, iron, zinc, copper and vitamin C were higher for the intervention group compared with the control group, only for iron was this difference significant. The iron intake was higher for group A compared with group B, even though a smaller number of babies were being iron supplemented (3% : 11%).

The mean protein energy ratio (PER) was significantly higher for the control group (15.6%) than for the intervention group (14.4%) and the control group achieved a higher intake of protein, sodium and calcium but these differences were not significant. These differences must originate from the differences in the types and proportions of different foods utilised in feeding the infants in each group.

There were no significant gender differences in intakes of the above nutrients.

<table>
<thead>
<tr>
<th>Table 3.5.v. Energy &amp; nutrient intakes at twelve months GCA- groups A &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Energy kj (kcal)</td>
</tr>
<tr>
<td>Protein g</td>
</tr>
<tr>
<td>Carbohydrate g</td>
</tr>
<tr>
<td>Fat g</td>
</tr>
<tr>
<td>Sodium mg</td>
</tr>
<tr>
<td>Calcium mg</td>
</tr>
<tr>
<td>Phosphorus mg</td>
</tr>
<tr>
<td>Iron mg</td>
</tr>
<tr>
<td>Zinc mg</td>
</tr>
<tr>
<td>Copper μg</td>
</tr>
<tr>
<td>Vitamin C mg</td>
</tr>
<tr>
<td>PER %</td>
</tr>
</tbody>
</table>

\[ a \ P = 0.04, \ b \ P = 0.03; \text{ intervention vs. control.} \]
3.6. Biochemical Results

3.6.i. Blood Test Results for All Infants at Zero Weeks GCA (Term)

The mean (SD) postnatal age of all babies at the first test was 8.5 (3.3) weeks and their mean (SD) gestation corrected age at the first test was 0.2 (1.4) weeks. The results for all biochemical analyses at term are shown in table 3.6.i.

Table 3.6.i. Blood test results at term- all infants

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Unit</th>
<th>Number</th>
<th>Mean</th>
<th>Median</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin</td>
<td>g/dl</td>
<td>68</td>
<td>10.3</td>
<td>9.4</td>
<td>2.5</td>
<td>7.1-18.6</td>
</tr>
<tr>
<td>Haematocrit</td>
<td></td>
<td>68</td>
<td>0.302</td>
<td>0.274</td>
<td>0.073</td>
<td>0.215-0.541</td>
</tr>
<tr>
<td>Serum Ferritin</td>
<td>ng/ml</td>
<td>65</td>
<td>72.4</td>
<td>57</td>
<td>50.0</td>
<td>7-229</td>
</tr>
<tr>
<td>Serum Iron</td>
<td>µmol/l</td>
<td>63</td>
<td>13.4</td>
<td>13</td>
<td>4.6</td>
<td>4-26</td>
</tr>
<tr>
<td>Serum Transferrin</td>
<td>g/l</td>
<td>63</td>
<td>1.9</td>
<td>1.8</td>
<td>0.4</td>
<td>1.0-3.0</td>
</tr>
<tr>
<td>Plasma Zinc</td>
<td>µmol/l</td>
<td>58</td>
<td>12.0</td>
<td>11.8</td>
<td>2.6</td>
<td>5.0-20.5</td>
</tr>
<tr>
<td>Plasma Selenium</td>
<td>µmol/l</td>
<td>62</td>
<td>0.49</td>
<td>0.49</td>
<td>0.15</td>
<td>0.21-0.88</td>
</tr>
<tr>
<td>RBC Selenium</td>
<td>µmol/l</td>
<td>56</td>
<td>1.68</td>
<td>1.67</td>
<td>0.40</td>
<td>0.7-2.55</td>
</tr>
<tr>
<td>Whole Blood Selenium</td>
<td>µmol/l</td>
<td>56</td>
<td>0.87</td>
<td>0.83</td>
<td>0.21</td>
<td>0.48-1.49</td>
</tr>
<tr>
<td>Blood Manganese</td>
<td>nmol/l</td>
<td>54</td>
<td>320</td>
<td>281</td>
<td>189</td>
<td>110-1129</td>
</tr>
<tr>
<td>Plasma Copper</td>
<td>µmol/l</td>
<td>51</td>
<td>10.1</td>
<td>9.4</td>
<td>2.6</td>
<td>5.8-17.0</td>
</tr>
<tr>
<td>Urea</td>
<td>mmol/l</td>
<td>60</td>
<td>2.4</td>
<td>2.3</td>
<td>0.9</td>
<td>0.5-4.7</td>
</tr>
</tbody>
</table>

The range of values for all analytes in the first test was wide.

The mean and median serum iron, plasma zinc and plasma selenium values were comparable to the levels of these minerals in preterm infants of a similar age in published data (Clayton and Round, 1994; Altigani et al., 1989; Rudolph et al., 1981). The mean and median urea and transferrin values were similarly comparable to published data (Clayton and Round, 1994). However, the mean and median serum ferritin values were lower than published values for preterm infants around term (Clayton and Round, 1994) and the mean and median haemoglobin and haematocrit values were higher than published values for preterm infants around term (Rudolph, 1981).
The indices of iron status, haemoglobin, serum ferritin and serum iron were significantly correlated \((p = 0.01)\) with gestational age at birth. Figures 3.6.i. and 3.6.ii. illustrate the pattern. Plasma selenium values were significantly correlated \((p = 0.01)\) with birth weight (Figure 3.6.iii.).

With the exception of plasma selenium, there were no differences in mean values of all blood analytes between infants who had been transfused \((n = 15)\) in the SCBU and those who had not received blood \((n = 52)\). Transfused infants had a significantly lower \((p = 0.008)\) mean plasma selenium level compared with those who had not received blood \((0.39\mu \text{mol/l}: 0.51\mu \text{mol/l}, \text{respectively})\). Similarly, mean plasma selenium values only were significantly lower \((p = 0.02)\) for babies who had received total parenteral nutrition compared with those who had not been fed in this way, \((0.42\mu \text{mol/l}: 0.52\mu \text{mol/l}, \text{respectively})\). These differences had disappeared by six months GCA (see Section 3.6.ii).

There were no significant differences in any blood test results between the intervention group (A) and the control group (B) at term. Similarly, there were no significant gender differences in blood analytes with the exception of whole blood selenium at term (see Section 3.6.iv.).

Fig. 3.6.i. Variation in haemoglobin values at term with gestational age at birth - all infants

![Graph showing variation in haemoglobin values at term with gestational age at birth.](image)

Pearson Correlation Coefficient = 0.493, \(p = 0.01\).
Fig. 3.6.ii. Variation in serum ferritin at term with gestational age at birth- all infants

Pearson Correlation Coefficient = 0.496, $p = 0.01$.

Fig. 3.6.iii. Variation in plasma selenium values at term with birth weight- all infants

Pearson Correlation Coefficient = 0.486, $p = 0.01$. 
3.6.ii. Blood Test Results for All Infants at Six Months GCA

The mean (SD) postnatal age of all babies at the second test was 35.1 (3.4) weeks. The mean gestation corrected age of all babies at the second test was 26.6 (1.7) weeks. Results from the second blood sampling are tabulated in Table 3.6.ii.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Unit</th>
<th>Number</th>
<th>Mean</th>
<th>Median</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin</td>
<td>g/dl</td>
<td>61</td>
<td>11.7</td>
<td>11.8</td>
<td>0.9</td>
<td>8.4-13.4</td>
</tr>
<tr>
<td>Haematocrit</td>
<td></td>
<td>61</td>
<td>0.346</td>
<td>0.346</td>
<td>0.026</td>
<td>0.260-0.408</td>
</tr>
<tr>
<td>Serum Ferritin</td>
<td>ng/ml</td>
<td>60</td>
<td>15.7</td>
<td>13</td>
<td>15.1</td>
<td>2-87</td>
</tr>
<tr>
<td>Serum Iron</td>
<td>µmol/l</td>
<td>57</td>
<td>10.9</td>
<td>10</td>
<td>4.9</td>
<td>2-23</td>
</tr>
<tr>
<td>Serum Transferrin</td>
<td>g/l</td>
<td>57</td>
<td>2.8</td>
<td>2.8</td>
<td>0.3</td>
<td>2.0-3.5</td>
</tr>
<tr>
<td>Plasma Zinc</td>
<td>µmol/l</td>
<td>54</td>
<td>13.8</td>
<td>13.2</td>
<td>2.5</td>
<td>9.1-22.7</td>
</tr>
<tr>
<td>Plasma Selenium</td>
<td>µmol/l</td>
<td>56</td>
<td>0.72</td>
<td>0.73</td>
<td>0.14</td>
<td>0.49-1.09</td>
</tr>
<tr>
<td>RBC Selenium</td>
<td>µmol/l</td>
<td>51</td>
<td>1.33</td>
<td>1.31</td>
<td>0.19</td>
<td>0.92-1.89</td>
</tr>
<tr>
<td>Whole Blood Selenium</td>
<td>µmol/l</td>
<td>50</td>
<td>0.94</td>
<td>0.95</td>
<td>0.12</td>
<td>0.68-1.23</td>
</tr>
<tr>
<td>Blood Manganese</td>
<td>nmol/l</td>
<td>50</td>
<td>211</td>
<td>202</td>
<td>68</td>
<td>86-400</td>
</tr>
<tr>
<td>Plasma Copper</td>
<td>µmol/l</td>
<td>56</td>
<td>19.2</td>
<td>19.1</td>
<td>3.6</td>
<td>10.5-26.4</td>
</tr>
<tr>
<td>Urea</td>
<td>mmol/l</td>
<td>56</td>
<td>4.6</td>
<td>4.7</td>
<td>1.1</td>
<td>1.8-7.1</td>
</tr>
</tbody>
</table>

At six months GCA, the range of values for haemoglobin, haematocrit, ferritin, transferrin, zinc, selenium and manganese had narrowed compared with the variation in values at term. The narrowing of the range of values between term and six months GCA for haemoglobin levels is illustrated in Figure 3.6.iv. Serum iron and urea ranges were substantially unchanged, and the range of plasma copper levels had widened compared with the variation in values at term.

Mean plasma zinc, selenium, copper, serum transferrin and urea levels increased significantly over time for all infants (p = 0.001). Mean serum ferritin, red blood cell selenium and blood manganese levels decreased significantly over time for all infants (p = 0.0001, 0.001, 0.002, respectively).

The variation in blood manganese levels only showed a significant correlation (p = 0.01) with postnatal age for the first test (around term) only, (Figure 3.6.v.)
Fig. 3.6.iv. Haemoglobin values at term and six months GCA - all infants

Fig. 3.6.v. Variation in manganese levels with postnatal age at testing - all infants

Pearson Correlation Coefficient = -0.656.
The mean and median haemoglobin, serum iron and plasma zinc values were comparable to the levels of these mineral in preterm infants of a similar age in published data (Clayton and Round, 1994; Friel & Andrews, 1994; Edmond, 1996). The mean and median plasma selenium, urea and transferrin values fell within the normal range of values for infants and children (Clayton and Round, 1994).

The mean and median serum ferritin and manganese values were lower than published values for preterm infants around six months GCA (Clayton and Round, 1994; Edmond, 1996) and the mean and median copper values were higher than published values for preterm infants at this age (Clayton and Round, 1994).

There were no significant gender differences in blood analytes with the exception of red blood cell selenium (see Section 3.6.v.) at six months GCA.

3. 6.iii. Blood Test Results of the Intervention and Control Groups at Six Months GCA

The results for both groups are shown in Table 3.6.iii.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Unit</th>
<th>Group A Mean</th>
<th>Group A SD</th>
<th>Group B Mean</th>
<th>Group B S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin</td>
<td>g/dl</td>
<td>12.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.7</td>
<td>11.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Haematocrit</td>
<td></td>
<td>0.35</td>
<td>0.022</td>
<td>0.34</td>
<td>0.028</td>
</tr>
<tr>
<td>Serum Ferritin</td>
<td>ng/ml</td>
<td>16.4</td>
<td>14.3</td>
<td>14.9</td>
<td>16.4</td>
</tr>
<tr>
<td>Serum Iron</td>
<td>µmol/l</td>
<td>12.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.7</td>
<td>9.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Serum Transferrin</td>
<td>g/l</td>
<td>2.7</td>
<td>0.3</td>
<td>2.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Plasma Zinc</td>
<td>µmol/l</td>
<td>13.7</td>
<td>2.6</td>
<td>14.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Plasma Selenium</td>
<td>µmol/l</td>
<td>0.73</td>
<td>0.16</td>
<td>0.72</td>
<td>0.11</td>
</tr>
<tr>
<td>Blood Manganese</td>
<td>nmol/l</td>
<td>205</td>
<td>49</td>
<td>221</td>
<td>89</td>
</tr>
<tr>
<td>Plasma Copper</td>
<td>µmol/l</td>
<td>19.3</td>
<td>3.5</td>
<td>19.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Urea</td>
<td>mmol/l</td>
<td>4.8</td>
<td>1.0</td>
<td>4.3</td>
<td>1.1</td>
</tr>
</tbody>
</table>

<sup>a</sup> p = 0.01, <sup>b</sup> p = 0.006; intervention vs. control.

There were no significant differences in mean levels of zinc, selenium, copper, manganese or urea between the intervention group (A) and the control group (B) at six months GCA. Some of the differences between groups in iron status at six months GCA were significant.
3.6.iv. Iron status of intervention and control groups at term and six months GCA

Some measures of iron status at six months GCA were significantly different for the two groups. The indices of iron status, mean (SD), between the intervention group (A) and control group (B) are illustrated at term (1st test) and six months GCA (2nd test) in Table 3.6.iv.

<table>
<thead>
<tr>
<th>Iron Indices</th>
<th>Unit</th>
<th>Number</th>
<th>All Infants Mean (SD)</th>
<th>Group A Mean (SD)</th>
<th>Group B Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin (1st)</td>
<td>g/dl</td>
<td>67</td>
<td>10.3 (2.5)</td>
<td>10.0 (2.1)</td>
<td>10.6 (3.0)</td>
</tr>
<tr>
<td>Haemoglobin (2nd)</td>
<td>g/dl</td>
<td>62</td>
<td>11.7 (1.0)</td>
<td>12.0 (0.7)</td>
<td>11.4 (1.1)</td>
</tr>
<tr>
<td>Serum Ferritin (1st)</td>
<td>ng/ml</td>
<td>65</td>
<td>72.4 (50.0)</td>
<td>68.9 (51.9)</td>
<td>76.7 (48.0)</td>
</tr>
<tr>
<td>Serum Ferritin (2nd)</td>
<td>ng/ml</td>
<td>60</td>
<td>15.7 (15.1)</td>
<td>16.4 (14.3)</td>
<td>14.9 (16.4)</td>
</tr>
<tr>
<td>Serum Iron (1st)</td>
<td>μmol/l</td>
<td>63</td>
<td>13.4 (4.6)</td>
<td>12.9 (4.6)</td>
<td>14.1 (4.6)</td>
</tr>
<tr>
<td>Serum Iron (2nd)</td>
<td>μmol/l</td>
<td>57</td>
<td>10.9 (5.2)</td>
<td>12.2 (3.7)</td>
<td>9.4 (5.7)</td>
</tr>
</tbody>
</table>

<sup>a</sup> = 0.01, <sup>b</sup> = 0.006; intervention vs. control. <sup>c</sup> = 0.001, <sup>d</sup> = 0.004; (2nd) vs. (1st).

There were no significant differences in the infants' ages at blood sampling between groups; nor were there any significant differences in iron indices between groups at term. However, haemoglobin and serum iron levels were significantly higher for the intervention group (A) compared with the control group (B) at six months GCA. In addition, the mean haemoglobin for the intervention group only increased significantly during the study, whilst the mean serum iron of the control group only decreased significantly during the study.

Serum ferritin levels decreased significantly over time for both groups. However more control group babies (50%) could be considered ferritin deficient (serum ferritin < 10 ng/ml) than intervention group babies (29%). This difference was not significant.

3.6.v. Selenium Status of Boys and Girls

There were no significant gender differences in blood test results at term or six months GCA with the exception of the selenium analyses. The mean (SD) values of plasma selenium (Se), red blood cell (RBC) selenium and whole blood selenium are shown in Table 3.6.v. for all infants and both sexes at term and six months GCA.

The girls had a significantly higher mean whole blood selenium at term and a significantly higher mean red blood cell selenium at six months GCA compared with the boys.
Table 3.6.v. Selenium Status results for all infants, boys and girls

<table>
<thead>
<tr>
<th>Selenium Indices</th>
<th>Unit</th>
<th>Number</th>
<th>All Infants</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma Se (1st)</td>
<td>µmol/l</td>
<td>62</td>
<td>0.49 (0.15)</td>
<td>0.47 (0.13)</td>
<td>0.51 (0.17)</td>
</tr>
<tr>
<td>Plasma Se (2nd)</td>
<td>µmol/l</td>
<td>56</td>
<td>0.72 (0.14)</td>
<td>0.70 (0.12)</td>
<td>0.75 (0.15)</td>
</tr>
<tr>
<td>RBC Se (1st)</td>
<td>µmol/l</td>
<td>56</td>
<td>1.68 (0.40)</td>
<td>1.59 (0.41)</td>
<td>1.78 (0.37)</td>
</tr>
<tr>
<td>RBC Se (2nd)</td>
<td>µmol/l</td>
<td>51</td>
<td>1.33 (0.19)</td>
<td>1.27 (0.16)</td>
<td>1.38 (0.21)</td>
</tr>
<tr>
<td>Whole Blood Se (1st)</td>
<td>µmol/l</td>
<td>56</td>
<td>0.87 (0.21)</td>
<td>0.80 (0.18)</td>
<td>0.93 (0.23)</td>
</tr>
<tr>
<td>Whole Blood Se (2nd)</td>
<td>µmol/l</td>
<td>50</td>
<td>0.94 (0.12)</td>
<td>0.91 (0.10)</td>
<td>0.97 (0.14)</td>
</tr>
</tbody>
</table>

*p = 0.04, p = 0.02; boys vs. girls

3.7. GROWTH RESULTS

3.7.i. Growth Measurements for All Infants

The means and standard deviations for length, weight and head circumference measured around term, six months gestation corrected age (GCA) and twelve months GCA for all infants are shown in Table 3.7.i.

The infants had a mean (SD) postnatal age of 9.5 (3.3) weeks, at term. At six months GCA, they had a mean (SD) postnatal age of 34.7 (3.5) weeks and at twelve months GCA, they had a mean (SD) postnatal age of 60.8 (3.1) weeks.

The variation in the range of values remains approximately equivalent at the three measurement points for length and head circumference, but increases over time, from 2.5 kg at term to 5.6 kg at twelve months GCA, for weight.

There were no significant differences in the final growth measurements between the babies who were breast-fed for more than six months and those who were breast-fed for a shorter time or who were bottle-fed entirely.
Table 3.7.i. Mean (SD) weights, lengths, head circumferences at zero, six & twelve months GCA - all infants

<table>
<thead>
<tr>
<th>Measurement</th>
<th>All Babies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>AT TERM (n = 68)</td>
<td></td>
</tr>
<tr>
<td>GCA (weeks)</td>
<td>1.1</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>49.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>3.00</td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td>35.3</td>
</tr>
<tr>
<td>AT 6 MONTHS GCA (n = 65)</td>
<td></td>
</tr>
<tr>
<td>GCA (weeks)</td>
<td>26.3</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>66.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>7.19</td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td>43.8</td>
</tr>
<tr>
<td>AT 12 MONTHS GCA (n = 65)</td>
<td></td>
</tr>
<tr>
<td>GCA (weeks)</td>
<td>52.2</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>75.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>9.16</td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td>46.5</td>
</tr>
</tbody>
</table>

3.7.ii. Growth Measurements for Groups and Sexes

Mean weights, lengths and head circumferences at term, 6 months GCA and 12 months GCA for the intervention Group (A), control group (B), girls and boys are shown in Table 3.7.ii. There were no significant differences in mean weights, lengths or head circumferences for the two groups at any measurement point. It should be noted that the group A babies were 0.5 week younger, on average, at the final measurement than group B babies. However, there were no significant differences between groups or sexes in mean postnatal ages or GCA at any measurement point.

The male babies were significantly longer at six and twelve months GCA compared with the female babies. The boys' mean head circumference was greater than the girls' mean head circumference at all measurement points.
### Table 3.7.ii. Mean (SD) weights, lengths, head circumferences for the intervention group (A), control group (B), girls and boys at zero, six & twelve months GCA

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Group A (n=37)</th>
<th>Group B (n=31)</th>
<th>Girls (n=33)</th>
<th>Boys (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AT TERM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCA (weeks)</td>
<td>1.2 (1.3)</td>
<td>1.1 (1.2)</td>
<td>1.2 (1.4)</td>
<td>1.2 (1.1)</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>49.4 (2.7)</td>
<td>49.6 (2.4)</td>
<td>49.3 (2.9)</td>
<td>49.6 (2.2)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>3.03 (0.55)</td>
<td>2.98 (0.57)</td>
<td>2.95 (0.60)</td>
<td>3.06 (0.51)</td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td>35.2 (1.49)</td>
<td>35.3 (1.3)</td>
<td>34.8 (1.4)</td>
<td>35.7 a (1.3)</td>
</tr>
<tr>
<td><strong>AT 6 MONTHS (n= 65)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCA (weeks)</td>
<td>26.0 (1.4)</td>
<td>26.7 (1.4)</td>
<td>26.1 (1.4)</td>
<td>26.5 (1.5)</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>67.1 (2.7)</td>
<td>66.1 (2.9)</td>
<td>65.8 (2.7)</td>
<td>67.5 b (2.6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>7.25 (0.93)</td>
<td>7.12 (1.05)</td>
<td>6.95 (0.99)</td>
<td>7.41 (0.93)</td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td>43.9 (1.5)</td>
<td>43.8 (1.3)</td>
<td>43.1 (1.1)</td>
<td>44.5 c (1.3)</td>
</tr>
<tr>
<td><strong>AT 12 MONTHS (n= 65)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCA (weeks)</td>
<td>52.0 (1.0)</td>
<td>52.5 (1.0)</td>
<td>52.0 (0.9)</td>
<td>52.4 (1.1)</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>75.3 (2.8)</td>
<td>74.7 (3.4)</td>
<td>74.2 (2.9)</td>
<td>75.8 d (3.1)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>9.18 (1.17)</td>
<td>9.13 (1.17)</td>
<td>8.87 (1.15)</td>
<td>9.43 (1.13)</td>
</tr>
<tr>
<td>Head Circumference (cm)</td>
<td>46.5 (1.6)</td>
<td>46.5 (1.2)</td>
<td>45.8 (1.1)</td>
<td>47.2 e (1.4)</td>
</tr>
</tbody>
</table>

* p = 0.007, b p = 0.01, c,e p = 0.0001, d p = 0.05; boys vs girls.

### 3.7.iii. Growth Velocities

The average rate of growth/week, which allows for age differences at measurement points, for both groups is shown in Table 3.7.iii.

<table>
<thead>
<tr>
<th>Rate of Growth/Week</th>
<th>All Babies</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Length (mm/week)</td>
<td>5.0</td>
<td>0.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Weight (g/week)</td>
<td>120.4</td>
<td>19.1</td>
<td>121.0</td>
</tr>
<tr>
<td>Head Circumference (mm/week)</td>
<td>2.2</td>
<td>0.3</td>
<td>2.2</td>
</tr>
</tbody>
</table>

* p = 0.04, A vs B.
The intervention group babies had a significantly greater mean rate of length growth than the control group babies, indicating faster length growth for the intervention group babies compared with the control group babies between term and twelve months GCA. Boys had a significantly greater mean rate of length growth/week than girls, 5.1mm : 4.9mm, respectively \( (p = 0.04) \). There was no difference in the sex ratio between the two groups. There were no significant group or gender differences in the average rates of weight growth/week and head circumference growth/week.

3.7.iv. Standard Deviation Scores for Length, Weight and Head Circumference

The mean SDS values for birth weight and for length, weight and head circumference at the three measurement points have been determined for all infants and for the intervention group A and the control group B, together with the mean SDS for birth weight. See Table 3.7.iv.

Table 3.7.iv. Standard deviation scores at birth, term, six months and twelve months GCA- all infants and both groups

<table>
<thead>
<tr>
<th>SDS</th>
<th>All Babies</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean SD</td>
<td>Mean SD</td>
<td>Mean SD</td>
</tr>
<tr>
<td>BIRTH (n = 68)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>-1.0 1.2</td>
<td>-0.9 1.3</td>
<td>-1.1 1.1</td>
</tr>
<tr>
<td>TERM (n = 65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>-1.1 a 1.3</td>
<td>-1.1 1.4</td>
<td>-1.0 1.2</td>
</tr>
<tr>
<td>Weight</td>
<td>-1.5 b 1.1</td>
<td>-1.5 1.1</td>
<td>-1.6 1.1</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>-0.2 c 0.9</td>
<td>-0.2 0.9</td>
<td>-0.1 0.9</td>
</tr>
<tr>
<td>6 MONTHS GCA (n= 65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>-0.1 1.2</td>
<td>0.2 1.2</td>
<td>-0.4 1.2</td>
</tr>
<tr>
<td>Weight</td>
<td>-0.8 1.3</td>
<td>-0.7 1.2</td>
<td>-1.0 1.4</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>-0.1 1.0</td>
<td>-0.1 1.1</td>
<td>-0.2 0.9</td>
</tr>
<tr>
<td>12 MONTHS GCA (n= 65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>0.11 a 1.22</td>
<td>0.2 1.1</td>
<td>-0.1 1.4</td>
</tr>
<tr>
<td>Weight</td>
<td>-0.7 b 1.2</td>
<td>-0.7 1.2</td>
<td>-0.8 1.3</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>-0.5 c 1.0</td>
<td>-0.5 1.1</td>
<td>-0.5 0.9</td>
</tr>
</tbody>
</table>

\( a, b, c P = 0.0001 \), term measurement vs. final measurement.
The standard deviation scores have been calculated by reference to the Cross-Sectional Reference Curves for Stature and Weight for the UK (Freeman et al, 1995).

For all infants, the increase in mean length SDS and mean weight SDS from term until twelve months GCA was significant and the decrease in mean head circumference SDS from term until twelve months GCA was significant.

The changes in SDS for length, weight and head circumference over the course of the study are illustrated in Figures 3.7.i., 3.7.ii. and 3.7.iii.

There was a decrease in the mean SDS (weight) between birth and the first study measurement at term from -1.0 to -1.5, indicating an increase in growth retardation in the SCBU.

There were no significant gender differences in SDS scores at any point.

**Fig. 3.7.i. Change in length SDS from term to one year GCA- all infants**

Repeated Measures ANOVA showed a significant effect due to group \((p=0.008)\)
Repeated Measures ANOVA showed no significant effect due to group.
3.7.v. Changes in Standard Deviation Scores

The change in SDS values for length, weight and head circumference between the term and the six month measurement points and between the term and final measurement points have been determined for all infants and for the intervention group A and the control group B. These changes are tabulated in Table 3.7.v.

Table 3.7.v. Changes in standard deviation scores- all infants and both groups

<table>
<thead>
<tr>
<th></th>
<th>All Infants</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean SD</td>
<td>Mean SD</td>
<td>Mean SD</td>
</tr>
<tr>
<td>CHANGE IN SDS (n= 65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>1.0 0.9</td>
<td>1.3* 0.8</td>
<td>0.6 0.9</td>
</tr>
<tr>
<td>Weight</td>
<td>0.7 0.9</td>
<td>0.8 0.8</td>
<td>0.6 1.0</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>0.0 0.7</td>
<td>0.1 0.7</td>
<td>-0.2 0.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHANGE IN SDS (n= 65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>1.2 1.0</td>
<td>1.4 0.9</td>
<td>0.9 1.1</td>
</tr>
<tr>
<td>Weight</td>
<td>0.8 1.1</td>
<td>0.8 1.0</td>
<td>0.8 1.2</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>-0.4 0.9</td>
<td>-0.4 0.8</td>
<td>-0.5 0.9</td>
</tr>
</tbody>
</table>

*P = 0.0003, intervention vs. control.

The mean change in length SDS from term until six months GCA was significantly higher for the intervention group (A) compared with the control group (B), indicating that the intervention group babies were growing faster in length than the control group babies between term and six months GCA.

When the few (n = 7) babies who received breast milk for more than six months were removed from the analysis, then the change in SDS (length) from term until twelve months was significant (p=0.04).

The individual change in SDS (length) for all the babies in each group, from term until one year GCA, are illustrated in Figures 3.7.iv. and 3.7.v.

There were no significant gender differences in changes in SDS scores.
Fig. 3.7.iv. Change in length SDS from term to twelve months GCA for group A infants

![Graph showing change in length SDS from term to twelve months GCA for group A infants.]

Fig. 3.7.v. Change in length SDS from term to twelve months GCA for group B infants

![Graph showing change in length SDS from term to twelve months GCA for group B infants.]
3.7.vi. Catch-up Growth

The Avon Longitudinal Study of Pregnancy and Childhood (Ong et al, 2000) defines catch-up growth as a gain of 0.67 standard deviations in height, weight or head circumference within a two year period. According to that definition, the following rates of length, weight and head circumference catch-up growth can be attributed to children in the study (Table 3.7.v.).

<table>
<thead>
<tr>
<th>SDS Change ≥ 0.67</th>
<th>All % (n)</th>
<th>Group A % (n)</th>
<th>Group B % (n)</th>
<th>Boys % (n)</th>
<th>Girls % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>64 (41)</td>
<td>75 (27) *</td>
<td>50 (14)</td>
<td>67 (22)</td>
<td>61 (19)</td>
</tr>
<tr>
<td>Weight</td>
<td>59 (38)</td>
<td>58 (21)</td>
<td>59 (17)</td>
<td>62 (21)</td>
<td>55 (17)</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>9 (6)</td>
<td>11 (4)</td>
<td>7 (2)</td>
<td>9 (3)</td>
<td>10 (2)</td>
</tr>
</tbody>
</table>

* p = 0.05, A vs B.

It should be noted that the mean SDS (head circumference) at term was close to zero (−0.2) and therefore the majority of infants could be presumed to have an appropriate head circumference for age at the beginning of the study and an acceleration in head growth would not have been anticipated.

A significantly greater number (p = 0.05) of intervention group infants compared with control group infants achieved catch-up growth in length. There were no significant group differences for weight and head circumference catch-up and no significant sex differences in any measure of catch-up growth.

3.7.vii. Body Proportion

The percentage of standard weight for height (Waterlow et al, 1977) was used to produce an indication of the relative body proportions of the study infants compared with all infants in the UK at the three measurement points.

\[
\% \text{ standard weight for height} = \frac{\text{Actual Weight}}{\text{Weight Corresponding to Height Centile}}
\]

The percentage of standard weight for height results for all infants, the intervention group (A) and the control group (B) are shown in Table 3.7.vi.
The changes in mean percentage of standard weight for height over the year were not significant and there were no significant differences in mean percentage of standard weight for height between groups or genders at any measurement point.

Table 3.7.vi. Changes in % standard weight for heights during - all infants, both groups

<table>
<thead>
<tr>
<th>% Standard Weight for Height</th>
<th>All Mean (SD)</th>
<th>Group A Mean (SD)</th>
<th>Group B Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Term</td>
<td>95.3 (13.1)</td>
<td>96.6 (15.1)</td>
<td>93.8 (10.3)</td>
</tr>
<tr>
<td>At Six Months GCA</td>
<td>92.5 (8.9)</td>
<td>91.3 (8.9)</td>
<td>93.9 (8.8)</td>
</tr>
<tr>
<td>At Twelve Months GCA</td>
<td>92.0 (7.0)</td>
<td>91.0 (7.1)</td>
<td>93.2 (7.0)</td>
</tr>
</tbody>
</table>

As a cohort, the study preterm infants percentages of standard weight for height were consistently lower than 100% and there was a more pronounced tendency for the intervention group babies to increase length growth to a greater degree than weight growth, i.e. become more lean over the year compared with the control group babies.

3.8 Relationships between Dietary, Biochemical and Growth Results

3.8.1 Correlations between Dietary Analyses and Biochemical Results

Zero Months GCA (term): There were no significant correlations between the dietary intakes of iron, zinc and copper and the corresponding blood analytes of the minerals, i.e. haemoglobin, serum ferritin, serum iron, plasma zinc and plasma copper, at term. Nor was there any apparent association between vitamin C intake and the measured indicators of iron status, i.e. haemoglobin, serum ferritin and serum iron.

There were no significant correlations between the dietary intake of protein and serum urea or serum transferrin levels from the first blood tests.

Six Months GCA: There were no significant associations between the daily iron intakes and levels of haemoglobin or serum ferritin at six months GCA. However, serum iron levels were significantly correlated with daily iron intakes and with daily iron intakes/kg body weight (Table 3.8.i.). Vitamin C intakes were not correlated with any measured indicator of iron status (haemoglobin, serum ferritin and serum iron) at this point.
There was no significant association between plasma zinc levels and daily zinc intakes or between plasma copper levels and daily copper intakes at six months GCA.

Daily protein intakes and protein intakes/kg body weight were significantly correlated with serum urea levels (Table 3.8.i.) but not with transferrin levels at six months GCA.

<table>
<thead>
<tr>
<th>Dietary Variable</th>
<th>Biochemical Variable</th>
<th>Pearson Correlation Coefficient</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron Intake</td>
<td>Serum Iron</td>
<td>0.36</td>
<td>0.01</td>
</tr>
<tr>
<td>Iron Intake/kg body weight</td>
<td>Serum Iron</td>
<td>0.33</td>
<td>0.05</td>
</tr>
<tr>
<td>Protein Intake</td>
<td>Serum Urea</td>
<td>0.51</td>
<td>0.001</td>
</tr>
<tr>
<td>Protein Intake/ kg body weight</td>
<td>Serum Urea</td>
<td>0.56</td>
<td>0.001</td>
</tr>
</tbody>
</table>

There were no significant associations between blood analytes from the second blood test and the age of first introduction of solid foods.

3.8.ii. Correlations between Dietary Analyses and Growth Results

**Zero Months GCA:** Length was significantly correlated with estimated daily intakes of energy, protein, zinc and vitamins A and C at term. Weight at term was significantly correlated with estimated daily intakes of protein, calcium, zinc and vitamins A and C (Table 3.8.ii.).

Head circumference was not significantly correlated with daily intakes of energy, protein, calcium, iron, zinc, copper or vitamins A and C at term.

At the beginning of the study, some measures of nutrient intake/kg body weight were negatively correlated with length, weight and head circumference. See Table 3.8.ii.

**Six Months GCA:** Length at six months GCA was significantly associated with daily protein, zinc and copper intakes at that time. Weight at six months GCA was significantly correlated with daily protein intake, only (Table 3.8.iii.). There were no significant correlations between the daily intakes of energy, protein, calcium, iron, zinc, copper and vitamin C with head circumference measurements at six months GCA.

Infant weights at six months GCA were significantly negatively correlated with daily energy intakes/kg body weight (Table 3.8.iii.). There were no other significant associations between growth measurements and nutrient intakes/kg body weight.
Standard deviation scores (SDS) for length at six months GCA were significantly negatively correlated with the ages at which solid foods were initially introduced (Table 3.8.iii.).

**Table 3.8.ii. Correlations: dietary intakes and growth at zero weeks GCA (term)**

<table>
<thead>
<tr>
<th>Dietary Variable</th>
<th>Growth Variable</th>
<th>Pearson Correlation Coefficient</th>
<th>Level of Significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Intake</td>
<td>Length</td>
<td>0.39</td>
<td>0.01</td>
</tr>
<tr>
<td>Protein Intake</td>
<td>Length</td>
<td>0.42</td>
<td>0.01</td>
</tr>
<tr>
<td>Zinc Intake</td>
<td>Length</td>
<td>0.45</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin A Intake</td>
<td>Length</td>
<td>0.31</td>
<td>0.05</td>
</tr>
<tr>
<td>Vitamin C Intake</td>
<td>Length</td>
<td>0.32</td>
<td>0.05</td>
</tr>
<tr>
<td>Protein Intake</td>
<td>Weight</td>
<td>0.48</td>
<td>0.01</td>
</tr>
<tr>
<td>Calcium Intake</td>
<td>Weight</td>
<td>0.41</td>
<td>0.01</td>
</tr>
<tr>
<td>Zinc Intake</td>
<td>Weight</td>
<td>0.48</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin A Intake</td>
<td>Weight</td>
<td>0.48</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin C Intake</td>
<td>Weight</td>
<td>0.39</td>
<td>0.01</td>
</tr>
<tr>
<td>Iron Intake/kg</td>
<td>Length</td>
<td>-0.36</td>
<td>0.05</td>
</tr>
<tr>
<td>Vitamin C Intake/kg</td>
<td>Length</td>
<td>-0.44</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin A Intake/kg</td>
<td>Length</td>
<td>-0.67</td>
<td>0.01</td>
</tr>
<tr>
<td>Iron Intake/kg</td>
<td>Weight</td>
<td>-0.52</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin A Intake/kg</td>
<td>Weight</td>
<td>-0.85</td>
<td>0.01</td>
</tr>
<tr>
<td>Vitamin A Intake/kg</td>
<td>Head Circumference</td>
<td>-0.45</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Table 3.8.iii. Correlations: dietary intakes and growth at six months GCA**

<table>
<thead>
<tr>
<th>Dietary Variable</th>
<th>Growth Variable</th>
<th>Pearson Correlation Coefficient</th>
<th>Level of Significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein Intake</td>
<td>Length</td>
<td>0.26</td>
<td>0.05</td>
</tr>
<tr>
<td>Zinc Intake</td>
<td>Length</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td>Copper Intake</td>
<td>Length</td>
<td>0.28</td>
<td>0.05</td>
</tr>
<tr>
<td>Protein Intake</td>
<td>Weight</td>
<td>0.28</td>
<td>0.05</td>
</tr>
<tr>
<td>Energy Intake/kg</td>
<td>Weight</td>
<td>-0.50</td>
<td>0.01</td>
</tr>
<tr>
<td>Age of Weaning</td>
<td>SDS (Length)</td>
<td>-0.34</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Twelve Months GCA: There were no significant associations between the daily intakes of energy, protein, calcium, iron, zinc, copper and vitamin C with length or weight measurements at twelve months GCA. Head circumference measurements were significantly correlated with iron intakes only at twelve months GCA (Table 3.8.iv.). However, weight at twelve months GCA was significantly negatively correlated with energy intake/kg of body weight (Table 3.8.iv.). There were no other significant associations between growth measurements and daily intakes/kg of body weight.

Standard deviation scores for length at twelve months GCA were significantly negatively correlated with the ages at which solid foods were first introduced (Table 3.8.iv.). This relationship, which parallels the earlier correlation at six months GCA, could be interpreted as signifying that earlier weaning promotes enhanced length growth.

Table 3.8.iv. Correlations: dietary intakes and growth at twelve months GCA

<table>
<thead>
<tr>
<th>Dietary Variable</th>
<th>Growth Variable</th>
<th>Pearson Correlation Coefficient</th>
<th>Level of Significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron Intake</td>
<td>Head Circumference</td>
<td>0.27</td>
<td>0.05</td>
</tr>
<tr>
<td>Energy/kg</td>
<td>Weight</td>
<td>-0.41</td>
<td>0.01</td>
</tr>
<tr>
<td>Age of Weaning</td>
<td>SDS (Length)</td>
<td>-0.28</td>
<td>0.05</td>
</tr>
</tbody>
</table>

3.8.iii. Correlations between Biochemical and Growth Results

Zero Months GCA: Length and weight were significantly associated with serum urea levels only, at term. Head circumference was positively significantly correlated with plasma copper levels only, at this point. See Table 3.8.v.

Table 3.8.v. Correlations: dietary intakes and growth at term

<table>
<thead>
<tr>
<th>Biochemical Variable</th>
<th>Growth Variable</th>
<th>Pearson Correlation Coefficient</th>
<th>Level of Significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Urea</td>
<td>Length</td>
<td>0.46</td>
<td>0.01</td>
</tr>
<tr>
<td>Serum Urea</td>
<td>Weight</td>
<td>0.44</td>
<td>0.01</td>
</tr>
<tr>
<td>Plasma Copper</td>
<td>Head Circumference</td>
<td>0.31</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Six Months GCA: There were no significant correlations between the levels of haemoglobin, serum iron, serum ferritin, plasma zinc or plasma copper levels and length, weight or head circumference measurements at six months GCA.
3.8.iv. Relationships between Dietary Intakes and Growth Results over Time

The results from the study produced three sets of growth measurements with three corresponding dietary analyses. Repeated Measures ANOVA was used to explore the effect of the change in dietary intakes over the course of the study upon infant growth performance. Growth velocities in length, weight and head circumference between term and twelve months GCA were compared with the three assessments of total daily intakes of energy, protein, calcium, iron, zinc, copper and vitamin C.

To remove any differences in growth variables due to gender, the analysis was repeated using the changes in standard deviation scores (SDS) for length, weight and head circumference between term and twelve months GCA as the dependent variable.

To perform the analyses each set of growth rates and changes in SDS were divided into quartiles. For example, length growth rates were divided into four parts, the lowest length growth rates were placed in the first quartile and the highest in the last quartile.

No effect was apparent for repeated measures of energy, protein, iron, zinc and vitamin C intakes on growth achievement for length, weight and head circumference or the change in any SDS over time. However, the trend in daily calcium intakes at the three assessment points significantly affected the variation in SDS for length \( (p = 0.01) \) and the growth rates for weight between term and twelve months GCA \( (p = 0.05) \). Head circumference growth rate and SDS change in head circumferences were unaffected by the changes in daily calcium intakes over time.

The analysis was then repeated comparing the intakes/kg body weight of energy, protein, calcium, iron, zinc, copper and vitamin C with growth velocities and changes in SDS for length, weight and head circumference. The nutrients/kg body weight, which demonstrated a statistically significant relationship with growth rates or SDS changes are shown in Table 3.8.vi.

No other relationships showed a significant association over time.

There was no significant influence on growth rates or the change in SDS for length, weight and head circumference between term and twelve months GCA by the age of first introduction of solid foods.
### Table 3.8.vi. Relationships between growth rates and change in SDS with nutrient intakes/kg

<table>
<thead>
<tr>
<th>Dietary Variable/kg body weight</th>
<th>Growth Rate</th>
<th>Significance (p)</th>
<th>SDS Change</th>
<th>Significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Intake</td>
<td>Weight</td>
<td>0.05</td>
<td>Weight</td>
<td>0.01</td>
</tr>
<tr>
<td>Energy Intake</td>
<td>Head</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein Intake</td>
<td>Weight</td>
<td>0.01</td>
<td>Length</td>
<td>0.01</td>
</tr>
<tr>
<td>Protein Intake</td>
<td>Head</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium Intake</td>
<td>Length</td>
<td>0.05</td>
<td>Length</td>
<td>0.01</td>
</tr>
<tr>
<td>Calcium Intake</td>
<td>Weight</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper Intake</td>
<td>Weight</td>
<td>0.05</td>
<td>Weight</td>
<td>0.05</td>
</tr>
</tbody>
</table>
CHAPTER 4

Discussion and Conclusions

4.1 Introduction

At present, there are no research based feeding policy guidelines for preterm infants after hospital discharge. As a group, children, who are born preterm and low birth weight, continue to be growth and developmentally retarded, throughout childhood (Fewtrell et al, 2000; Lagerstrom et al, 1994).

Previous studies have indicated that the post hospital discharge nutritional needs of these infants are not being met by current feeding practices (Cooke et al, 1998; Lucas et al, 1992a). This nutritional inadequacy may be responsible, at least in part, for the growth deficit experienced by these children.

This unique study was undertaken to determine if a feeding strategy, specifically designed for preterm infants after hospital discharge, could improve their growth and concurrent development. The study compared growth, dietary intake and biochemical outcomes in preterm infants subjected to two different solid feeding regimens between hospital discharge and one year gestation corrected age in a blinded, randomised intervention.

At the beginning of the study, it was hoped that if any aspect of the infants' growth was shown to be enhanced, as a result of the preterm infant feeding strategy, then the recommendations of the feeding strategy could be used, in the future, to provide evidence based nutritional information to the parents of preterm infants and to health care professionals.

The significant outcomes from the growth, dietary and biochemical results are discussed in this chapter.
4.2 Study Subjects

4.2.i. Subject Characteristics
The subjects in this study were in many respects representative of preterm infants in the UK, although there were some recorded differences between them and the infant population in general. The number of subjects recruited (68) was within the calculated number (65-70) required to demonstrate a significant difference in outcome growth measures and all infant subjects fulfilled the study criteria. The slight gender imbalance (there were two more boys than girls in the subject cohort) was not statistically important. Unfortunately, all the infants except one were of white Caucasian origin; hence the subject group did not reflect the current ethnic mix of the UK population as a whole but did mirror that of the local population. The study drop out rate was 4% (less than half the anticipated rate of 10%), this confirms the relevance of the study to the subject families and their commitment to the study.

4.2.ii. Study Family Characteristics
The distribution of social classes in the study families was broadly similar to that of the UK population. However, there were some differences in characteristics between the study families and the population as a whole. These may have originated either from the differences between the parents of preterm babies and those of full-term babies or from regional differences within the UK.

The number of infants in the study (18%) born as a result of multiple birth was higher than the national rate (1%; Foster et al., 1997). This was a consequence of recruiting preterms. The greater proportion of mothers aged over 30 years (55%) in the study cohort, compared with the UK generally (40%; Foster et al., 1997), was due to a combination of factors. Several subject infants were born after in vitro fertilisation (IVF), which is used by couples who have experienced difficulty conceiving and often repeated IVF procedures are undertaken before conception occurs. Therefore, pregnancy after IVF, occurs at a later maternal age compared with pregnancy achieved by the traditional method. In addition, there are many towns, city suburbs and village areas of Hampshire with stable, relatively affluent populations, who conventionally delay childbearing. These same factors will have contributed to the lower smoking rates amongst study mothers (15% : 26%) compared with national rates (Office of Population Censuses and Surveys, 1991a), the larger number of first born children in the
study (49% : 39%) and the smaller number of single parents of new babies in the study, 10% : 16%, compared with the UK Population rates (Foster et al, 1997).

4.2.iii. Study Assessments
Even though, strenuous efforts were made by the researcher and study families, it proved impossible to perform all measurements and tests within the designated time period of ± two weeks of each assessment age, that is zero weeks gestation corrected age (term), six months gestation corrected age (GCA) and twelve months GCA. The commitment of parents to the study was demonstrated by their willingness to permit visits even under difficult circumstances. However, occasionally infectious illnesses, holiday commitments and confusions over appointments contributed to delay in assessment. Notwithstanding, the great majority of growth measurements, diary completions and blood tests were carried out within the specified time-period, although one or two at each assessment point were performed up to three weeks after the specified age.

4.2.iv. Compliance with Study Regimens by Subject Families
Of the 68 families who originally consented to join the study, two families withdrew after the first study visit and one withdrew at the second visit. The subjects in two of these families had twins and their mothers decided they were too busy to fully comply with the study programme. The third family withdrew citing reluctance to allow a second blood test. When comparisons were made between the families who remained in the study with the three families who dropped out of the study, only one difference in infant or family characteristics was identified. Two thirds of withdrawals involved families with twins compared with those completing the programme (15%). The loss of two families with twins is understandable, when the increased work and anxiety associated with multiple births is considered. In all other cases, the study protocols were embraced enthusiastically by the majority of parents and willingly by the remainder. No parents refused permission for a study visit for the purposes of anthropometric determinations, blood sampling or diary collection, with three exceptions. One mother of twins apologetically declined to complete the third dietary assessment at twelve months GCA. Another mother was receiving chemotherapy during the second half of the study and was too tired and anxious to complete a diary. A third mother refused permission for her child to be weighed at twelve months GCA but the child's weight
was obtained, at the mother's suggestion, from his health visitor who had visited the family a few days earlier.

Adherence to protocols by those taking part in the study was maintained by frequent visits of the researcher to the study families, by disclosure and interpretation of growth and blood results to parents and by operation of a telephone study help-line. These measures helped forge and maintain good relationships between the researcher and all study families. The two coffee mornings organised by the researcher at RHCH during the course of the study were a further positive influence on maintaining parental goodwill. They enabled parents to socialise with each other, to meet the study organisers and to revisit the Neonatal Unit.

Analysis of the feeding records compiled by parents (Section 3.3) demonstrated excellent compliance with the recommendations on when to introduce solid foods and the order and type of foods to be introduced in the Feeding Guides for the two groups. Good rates of compliance did not extend to the recommendations concerning the delay in the transition to cow's milk from human or formula milks until twelve months GCA. These were not followed by the majority of control group parents.

More than two thirds (71%) of control group parents had changed their child's milk to cow's milk by twelve months GCA or were in the process of changing their child's milk to cow's milk at that point. However, the variety in ages at the changeover to cow's milk was a desirable reflection of common practice for full-term infants (Foster et al, 1997).

In contrast, the majority of intervention group parents (62%) had not begun the transition to cow's milk by this stage.

4.2.v. Acceptance of Study Regimens by Health Care Professionals

Most health visitors acknowledged their inability to provide feeding advice specifically for preterm LBW infants and welcomed the study after presentations to inform health visitors about the study were made in the Health Districts from which subjects were predominantly recruited. The information letter sent to each individual subject's health visitor after recruitment, helped to establish good relationships with the area health visitors involved in caring for study infants. The invitations to health visitors in the presentations and within each letter to contact LM for further information about the study resulted in several contacts with health visitors. No negative attitudes to the study were detected within the profession.

Without the full support of the Royal Hampshire County Hospital (RHCH) Neonatal Unit staff, the hospital paediatricians and Children's Outpatient Clinic nurses, recruitment of
subjects would have been slower and arrangements for blood testing would have been very difficult. Assistance from RHCH medical staff, the Haematology and Biochemistry Departments made an enormous difference to the smooth running of the study.

4.2.vi. Differences between Subject Groups at the Study Outset
There were no significant differences in birth weight, gestational age or sex ratio between the intervention and control groups. This had been ensured by the randomisation system devised by Dr A.C. Kimber, University of Reading, for group allocation. Serendipitously, there were no significant differences in family characteristics, neonatal care or social class distribution between groups. This similarity in group characteristics increased the probability that differences in group outcome measures resulted from variations in the feeding regimens rather than from confounding variables.

4.3 Milk Feeding Patterns

4.3.i. Breast Feeding
Over 90% of study mothers breast-fed for at least part of the time during their stay in the neonatal unit, this level of breast-feeding reflected the level of commitment to their infants' best interests demonstrated by study parents. The initial breast-feeding rate amongst study mothers was considerably higher than the initial breast-feeding rates for both LBW babies (63%) and babies of all birth weights (66%) reported in a national survey (Foster et al, 1997). Of those who received human milk the majority, 70% (n = 45) had breast milk fortifier (BMF) mixed with the milk, for one or more days, to increase the energy and nutrient density of the milk. Statistically more intervention group infants received BMF than control group infants. However, this difference had no impact on growth measurements or growth velocities at any point during the study.

By the first study assessment point at zero weeks GCA (term), many mothers reported difficulties with breast-feeding. The main problem was a perceived insufficiency of supply with an associated anxiety about infant hunger. Consequently, only 41% (n = 27) of infants were still receiving human milk at this stage. This proportion dropped to 11% (n = 7) at the
second study assessment point at six months GCA and only one subject (2%) received any human milk at the final study assessment point at twelve months GCA. There were no significant group differences in breast feeding rates throughout the study. Although, at six months GCA babies still receiving human milk were significantly lighter than wholly bottle-fed babies, there were no differences in growth measurements at twelve months GCA attributable to method of milk feeding during the study.

4.3.ii. Changes in the Pattern of Formula Feeding during the Study
The great majority of study infants were fed either a mixture of milks or received different types of milk at different times during their stay in the neonatal unit. Low birth weight formula was given, either alone or in combination with human milk, to 91% of infants in the neonatal unit, but only one infant was prescribed LBW formula for his main milk after discharge from hospital. Other researchers have chronicled the significant effects on growth and development associated with differing milk feeding regimes in the perinatal period (Lucas et al, 1997; Gross & Thomas, 1996; Lucas et al, 1994b). In this study, measurements at term identified a significant difference in weight only between those infants still receiving human milk at term compared with those fed an infant formula at that time. At the first study assessment point at term, formula-fed infants were most likely to receive a whey-dominant cow's milk formula (91%), the introduction of casein-dominant cow's milk formula at this point (4%) was much less likely than for full-term infants (37%) (Foster et al, 1997). In line with the study protocol, follow-on formula was introduced from eight months of postnatal age onwards (six months GCA). Fortuitously, there were no statistically significant group differences in milk feeding patterns up to six months GCA. At twelve months GCA, there was a significant group difference for formula-fed infants with respect to follow-on formula. More intervention group children (n = 15) were receiving follow-on formula than control group children (n = 5), (p = 0.04); this discrepancy reflected the difference in milk feeding recommendations to the two groups. Intervention group parents of bottle-fed infants were strongly urged in the Feeding Guide and by the researcher to use a follow-on formula from eight months of postnatal age until twelve months GCA. Control group parents of bottle-fed infants were advised that follow-on formula could be used from eight months of postnatal age and that formula milk should be used until twelve months GCA. Information about the benefits of different formulas was supplied on request to control group parents.
The dietary intake consequences of this group difference are discussed in 4.4.iv.

4.3.iii. Introduction of Cow's Milk

At twelve months GCA, approximately half of the study subjects (54%) were drinking whole cow's milk as their only milk drink or were in the process of changing to cow's milk, which is a lower usage rate than that reported (66%) in a national survey of full-term infants aged between six to twelve months (Mills & Tyler, 1992). The difference between groups in uptake of cow's milk as their main milk drink at twelve months GCA was significant, intervention 38% : control 71%, (p = 0.04). Several parents perceived follow-on formula, as superior nutritionally to cow's milk and declared their intention of continuing to use follow-on formula as the main milk for their children after twelve months GCA.

The variation in main milk drinks at twelve months GCA between groups may partially explain the differences in mean daily nutrient intakes at that age. See 4.4.iv.

4.4 Patterns in Solid Feeding

4.4.i. Introduction of Solid Foods

The overall mean postnatal age for the introduction of the first solid food was 16.3 (SD 3.6) weeks, with a wide range of ages varying from 10.6-25.4 weeks. Two mothers in the intervention group introduced solids before the earliest recommended postnatal age of 12 weeks. Otherwise, parents in both groups complied with the respective recommendations for their group, from three months for the intervention group and from four months for the control group.

Group allocation in this study cohort appears to have overridden the normally observed effect of social class on the age of the introduction of the first solid food (Foster et al, 1997). From the results, the age of first solid food introduction depended upon group orientation (mean age = 14.9 weeks for the intervention group : 17.8 weeks for the control group, p = 0.01); the child's gestational age at birth (Pearson Correlation Coefficient = -0.36, p = 0.01); and the mother's subjective perception of weaning readiness.

To improve nutritional intake and consequently growth velocity, the study hypothesis included weaning from three months of postnatal age as a primary requirement.
The possibility of an association between early weaning (<15 weeks of age) and higher rates of respiratory diseases (Wilson et al, 1998) has been used, inter alia, as evidence to recommend later weaning for all infants. Practical and resource limitations prevented an objective record of respiratory, gastrointestinal or allergy problems from being undertaken during the study. However, no group difference in illness prevalence was observed empirically for the study duration. The apparent absence of evidence for an association between early weaning and illness in the current study may be caused by one or a combination of the following factors:

- the weakness of the association,
- the association may not operate for preterms,
- the significant group variation in mean ages for weaning may not be sufficiently great to produce any noticeable effect,
- the care taken to recommend foods of low allergenicity may have negated any effect.

Both groups followed the recommended order of introduction for different types of foods for their group, as delineated in their respective Feeding Guides (Appendices V & VI)). To increase nutrient density in the weaning diet, the intervention group introduced vegetable meals after cereal meals and then fruit was offered in combination with other cereal/dairy foods. The control group conformed to common practice by introducing fruit and/or vegetables after cereals. Cheese meals, followed by meat dishes were then introduced by both groups.

Compliance with feeding guide recommendations produced two significant differences in patterns of weaning, in addition to the significantly earlier introduction of solid foods by the intervention group compared with the control group. Firstly, the mean age of infants at the introduction of the first vegetable meal was earlier for the intervention group compared with the control group. This difference arose because of the variation in the sequence of introduction of types of foods. Secondly, the choice of first vegetable meal was different for the two groups. This difference was a reflection of the specific vegetable meal recipes contained in the respective Feeding Guide for each group.

Intervention group parents were instructed to introduce vegetables after cereals, with all home made vegetable meals containing potato and Nutriprem inter alia. Control group parents were advised to introduce fruit and vegetables after cereals, with a wider choice of suggested home made fruit and vegetable meals. Commercial meals for both groups conformed to the energy and protein minima described in Section 2.5.i.
The choices of first solid foods in the broad food type categories, cereal, vegetable, fruit, dairy and cheese, meat and fish, together with the rate and order of introduction of foods were monitored closely.

The detailed practices used during weaning for preterm LBW infants have not previously been reported.

The combination of the earlier onset of weaning, the elimination of fruits as the second type of solid food to be introduced, the increased energy and increased nutrient density of solid foods and a greater uptake of follow-on formula milks produced a significant effect on some measures of mean dietary intakes at six months GCA and twelve months GCA between groups (Section 4.4.iv.).

Restriction of food choice was not perceived as problematical by parents. During the course of visits to parents, the researcher asked if the limited range of commercial foods in the Feeding Guides caused any difficulties. One control group parent experienced occasional difficulties in obtaining specified foods from her local shop, all other parents expressed satisfaction with the choice range.

4.4.ii. Changes in Energy and Nutrient Intakes over Time for All Infants

Over the course of the study, the mean daily intake of energy/kg body weight dropped significantly for all infants by approximately 20% (585kj : 459kj). This decrease occurred by six months GCA with no further reduction between six and twelve months GCA. It can be surmised that the reduction in volume of food/kg body weight during infancy and the significant reduction in energy from fat between term and six months GCA were primarily responsible for the decrease in mean daily energy intake/kg body weight. The decrease in intakes of energy/kg body weight and fat/kg of body weight was indicative of the change in infant requirements from term until twelve months GCA.

The gradual transition from a baby milk alone (with high fat content and relatively low protein content) at term through a mixed diet containing a relatively large amount of a baby milk at six months GCA to the family habitual diet and less milk at twelve months GCA was responsible for the varying proportions of energy derived from protein, fat and carbohydrate at the three assessment points. Similarly, the following specific alterations in dietary intakes over the course of the study resulted from the changes in infant diets between term and twelve months GCA.
Mean daily intake of protein /kg of body weight increased significantly between term and six months GCA, and again between six months and twelve months GCA.

Mean daily intakes of carbohydrate/kg of body weight decreased steadily over the course of the study, the overall change was significant.

Mean fat intake/kg of body weight decreased significantly between term and six months GCA, but increased slightly between six months GCA and twelve months GCA.

The increases in protein/kg body weight during the study were a consequence of the higher protein content of solid baby foods used in the study compared with human milk and formula. Thus, the weaning diet increased mean protein intakes/kg body weight for both groups at six GCA and twelve months GCA compared with intakes at term, such that the mean total intake and the mean protein intake/kg body weight were equivalent to or exceeded both the Tsang recommendations and the RNI for protein at six and twelve months GCA. This result confirms one of the benefits of weaning for preterm LBW infants.

The overall decrease in intakes of fat/kg body weight during the study was a consequence of the lower fat content of solid baby foods used in the study and those in common use compared with human milk and formula.

The decrease in mean carbohydrate/kg of body weight as infancy progressed, resulted from the variation in the carbohydrate content of the habitual diet of study families compared with human milk and formula milk.

The mean daily intakes/kg body weight of the specified minerals and vitamin C decreased significantly over the course of the study with the exceptions of sodium and phosphorus. The significant increase in sodium intakes reflected the changes from baby milk alone, then with commercial and home prepared baby foods (with low salt levels) to habitual family foods, including sizeable contributions from processed foods, with considerably higher salt contents. The total mean intake of sodium (1035mg/day) at twelve months GCA was considerably higher than the RNI for sodium (500mg/day) for this age group (DoH, 1991).

Repeated warnings were given to parents about the dangers of excessive salt intakes for infants. Consequently, the majority of parents were conscientious about keeping salt intake to a minimum for their infants. However, once study subjects, at around one year of age, began eating the habitual family diet, their sodium levels inexorably rose. High sodium intakes are a matter of concern for the UK population in general rather than for the study subjects, in
particular, because infants from four months of age can conserve water and deal with varying solute concentrations (DoH, 1994).

The increase in phosphorus intakes was attributable to the introduction of meat, poultry, fish, eggs and cow's milk into the children's diets, in gradually increasing amounts. The mean total phosphorus intake at twelve months GCA would have been expected to rise from earlier levels, given the transition to the habitual family diet and was not a cause for concern.

The mean daily intakes of iron/kg body weight and vitamin C/kg body weight were primarily reduced over time by the decline in uptakes of vitamin supplements (100% uptake at term, 23% at study end) and mineral supplements (88% uptake at term, 7% at study end). The reduction in usage and volume of intake of milk formulas by most infants in the later stages of infancy and a change to eating more habitual family foods rather than fortified commercial baby foods contributed to the decline in daily intakes of iron/kg body weight, calcium/kg body weight, zinc/kg body weight, copper/kg body weight and vitamin C/kg body weight. In addition, the overall decrease in food volume intakes/kg body weight during infancy led to a corresponding reduction in intakes of these minerals and vitamin C.

However, the reduction in intakes/kg body weight should not be viewed as disadvantageous, the mean, whole body intake for all micronutrients increased during the study and by study end, the mean intakes of all of these nutrients was equal to or greater than recommended levels. See 4.4.iii.

4.4.iii. Comparison of All Preterm Infants' Intakes with Recommended Intakes

At term: Although mean intakes/kg body weight of energy, iron, zinc and vitamin C equalled or exceeded the Tsang Recommendations for Stable Growing Preterm Infants (Appendix I) at term, the mean daily intakes/kg body weight of protein, sodium, calcium and copper were lower than recommended levels. This was a consequence of all the infants (except one) receiving human milk (without BMF), a standard milk formula or a combination of the two as their only food source around term i.e. after hospital discharge.

This result confirms the assertion (Section 1.3.ii.) that human milk and standard milk formula cannot meet the protein requirements of preterm infants around term. Satisfaction of protein requirements is crucial to promote optimum growth (Cooke et al, 1998; Millward, 1995). Deficiencies in the provision of minerals may also lead to growth curtailment (Jackson & Wootton, 1989).
A comparison of the mean daily intakes with the Dietary Reference Values Reference Nutrient Intakes (RNI) for full-term infants around term (DoH, 1991; Appendix I) indicated a similar shortfall in mean daily intakes of protein, sodium, calcium and copper; mean phosphorus intake also appeared deficient.

Thus, the shortfall in provision of protein and some minerals to preterm LBW infants is evident from a comparison with both sources of appropriate recommendations for nutrient requirements.

At Six Months GCA: After the introduction of solid foods, the mean daily intakes of the study infants exceeded the Estimated Average Requirement (EAR) for energy for full-term infants around six to nine months of age (DoH, 1991; Appendix I) and they were consuming more than the RNI for all other specified nutrient (DoH, 1991; Appendix I). However, comparison of dietary intakes with the Tsang Recommendations for Stable Growing Preterm Infants (Appendix I) indicated that mean zinc intake/kg body weight was below the recommended level. Thus, for some infants, zinc may have been the limiting nutrient for growth (Jackson & Wootton, 1989) and growth during mid-infancy may have been compromised for those infants. The diversity in growth patterns within both groups may be partially attributable to zinc deficiency in the diets of individual infants at this point.

The improvement in achieving nutrient requirements overall is another benefit of weaning for preterm LBW infants.

At Twelve Months GCA: The mean daily intake of energy was comparable to the EAR for energy for full-term infants around one year of age (DoH, 1991; Appendix I). Mean daily intakes of protein, sodium, calcium and phosphorus greatly exceeded the RNI for these nutrients for full-term infants around one year of age (DoH, 1991; Appendix I). The iron, zinc and copper mean daily intakes were approximately the same as the RNI for full-term infants around one year of age (DoH, 1991; Appendix I).

Summary: It can be concluded from these observations that at the beginning of the study, a substantial proportion of infants were not realising their requirements for protein and some minerals but, by the end of the study, the infants' mean intakes equalled or exceeded the recommendations for full-term infants of the same gestational age. The mean protein: energy ratio (PER) increased successively throughout the study, from 8.9% at term to 15% at twelve months GCA. At study start, it appeared that even if an individual infant's energy requirement was satisfied, his/her PER was too low to sustain catch-up growth (11%; Cooke et al, 1998). At study end PER was substantially higher than the minimum PER.
necessary for catch-up growth and thus macronutrient inadequacy was no longer an impediment to growth. Growth, for the majority of infants, should not therefore have been constrained by nutritional factors once solid feeding was well established.

4.4.iv. Comparison of Intervention Group's Intakes with Control Group's Intakes

At term: Unsurprisingly, there were no significant differences in mean daily intakes of energy or specified nutrients between groups at term. All infants except one were receiving human milk, a baby milk formula or a combination of the two as their only food source at this point, with no differences in milk feeding pattern between groups.

At Six Months GCA: By six months GCA, the intervention group had achieved higher mean daily intakes of energy and all specified nutrients compared with the control group. In the case of energy, protein and carbohydrate these differences (13%, 16% and 16% higher, respectively) were statistically significant. However, the differences did not reach significance when mean intakes/kg body weight were considered. The group means/kg body weight must be assumed to be reduced, not only by arithmetic division by body weight but also by fluctuations in intakes with size. The intervention group had a higher mean iron intake (3%) than the control group, although this difference was not significant, even though the latter had a greater uptake of iron supplements at six months GCA.

These results confirm that there was an important impact on nutrient intakes by the combination of "early weaning" and the use of energy and nutrient dense solid baby foods at this point in the study.

At Twelve Months GCA: At the final assessment point, mean daily intakes of energy, carbohydrate, iron, zinc, copper and vitamin C were higher for the intervention group compared with the control group; the difference for iron was statistically significant. This difference was not significant when mean iron intake/kg of body weight was calculated.

By one year GCA, it was anticipated that all the subjects would be consuming at least some habitual family foods, and that this would consequently reduce group differences in energy and nutrient intakes. However, the significant difference in group milk feeding patterns at this age arising from the recommendations in the Feeding Guides, is believed to have been responsible, at least in part, for the significantly greater mean iron intake by intervention group children. Furthermore, the greater emphasis placed on meat in the diet for intervention group infants compared with the control group infants probably contributed to increased iron intakes for the intervention group.
The differences in the consumption of follow-on formula and meat by intervention group infants may have been factors in other, non-significant, dietary differences between groups, specifically differences in zinc and copper intakes. Similarly, the statistically greater uptake of cow's milk as a main drink for control group infants was a major factor in accounting for the significantly higher mean protein intake of the control group children compared with that of the intervention group. The difference in protein intakes was not significant, nor was the lower intake of the intervention group a matter of concern as both groups were consuming more than twice the RNI for protein for full-term infants at one year of age (DoH, 1991).

4.4.v. Effect of Gender on Dietary Intakes
There were no significant differences between mean daily dietary intakes between all boys and all girls at any of the three study assessment points. This replicates the results of Cooke et al (1998), who similarly failed to find any significant gender differences in intakes in a study of 86 preterm infants.

A gender difference in energy intakes might possibly have been expected at zero, six and/or twelve months GCA. However, the Dietary Reference Values (DoH, 1991) stipulate varying values for total EAR for energy according to sex and age but the same EAR/kg of body weight for both sexes at each age. Hence, for infants, age-related differences are much larger than sex-related ones. In addition, the wide range of values for daily energy intakes at all analysis points may have required a larger sample size to detect any gender differences.

4.5 Biochemistry

4.5.i. Blood Levels of All Preterm Infants at Zero Weeks GCA (Term)
As expected, gestational age at birth and birth weight were significantly correlated with the values of several blood analytes at term, reflecting the increase of fetal mineral stores during gestation. Haemoglobin, serum ferritin and serum iron were all significantly associated with gestational age, and plasma selenium was significantly associated with birth weight. Clinical interventions in the Neonatal Unit had no observable effects on blood analyses, with the exception of plasma selenium levels. Babies who had received one or more blood transfusions or who had received total parenteral nutrition had significantly lower plasma
selenium levels at term compared with those who had not received these treatments. These effects were transitory and had disappeared by six months GCA.

In general, the blood test results were comparable with other published data on mineral, urea and transferrin levels for preterm infants (Section 3.6.i.). However, the mean value of serum ferritin at term could be considered to indicate lower iron stores in the study cohort than those assessed in other preterms (Clayton & Round, 1994).

There is little available published information on the levels of plasma zinc, plasma selenium, plasma copper and whole blood manganese for preterms around their expected dates of delivery. The study results on these minerals will constitute reference data, when published in the scientific literature.

4.5.ii. Preterm Infants' Blood Levels at Six Months GCA

For the group as a whole, there was a narrowing in the range of values of analytes at six months GCA compared with the levels at term, except for the range of plasma copper values. Mean values of plasma zinc, selenium, copper, urea and transferrin had all increased significantly by the time of the second blood test. This increase in mineral and urea status reflects the infants' improved stores of minerals and protein via nutrient intake. The decrease in blood manganese levels with age is believed to indicate the gradual movement of manganese from the blood to storage in the tissues (H.T. Delves, Trace Elements Specialist, personal communication). This transition in manganese blood: tissue partition gave rise to blood manganese values for the study infants at six months GCA, which are more representative of infant values at that age.

Whilst mean values of haemoglobin and serum iron increased significantly between the first and second blood test, the mean value of serum ferritin decreased significantly, so that 40% of infants could be classified as ferritin deficient (serum ferritin < 10ng) at six months GCA. The rather perplexing combination of improved haemoglobin and serum iron status with poorer serum ferritin status at six months GCA compared with term may have betokened a change in the division of body iron between red blood cells and plasma components from term to six months GCA. Griffin et al (1999) observed a similar range of haemoglobin values for preterm infants aged eight months postnatally but only 14% were described as ferritin deficient at that age. Sherriff et al, (1999) measured haemoglobin and ferritin levels in full-term infants at eight months of age, less than 5% of whom were ferritin deficient. However, she did report a significant correlation between growth velocity and ferritin levels for infants between eight
and twelve months of age. The ferritin levels in the study subjects may therefore have been reduced by the increased growth velocity manifested by the infants. See Section 4.6.ii.

The mean values of haemoglobin, serum iron and plasma zinc values were comparable to published values for preterm infants whilst mean values of serum ferritin and blood manganese were lower than published values for preterm infants and mean plasma copper values were higher. The difference between the mean copper level of the subjects and previously published values (Clayton & Round, 1994) may have originated in the recent increase in copper content of infant milk formulations in line with the Infant Formula and Follow-on Formula Regulations (Statutory Instrument No.77, 1995) and/or the variation in copper content of water supplies with geographical location.

In general, lack of comparability between study values and published data may be caused by changes in the nutritional management of preterms in recent years or in innate differences in cohort characteristics. Reassuringly, the mean levels of plasma selenium, plasma transferrin and urea were within the normal ranges for infants (Biochemistry Dept. RHCH, 1998) of the same gestation corrected age.

4.5.iii. Comparison of Intervention and Control Groups' Blood Results

As anticipated, there were no significant group differences in the mean values of any mineral, urea or transferrin from the first blood sampling at term.

As there were no significant differences in the mean values of serum ferritin, plasma zinc, plasma selenium, plasma copper, blood manganese, blood urea and plasma transferrin between the intervention group and the control group, at six months GCA, it is assumed that the differences in feeding regimens between groups had not affected these biochemical indices.

However, the intervention group had significantly higher mean haemoglobin and mean serum iron levels than the control group, at six months GCA. Furthermore, the mean haemoglobin level of the intervention group had increased significantly between tests whereas that of the control group did not. At the same time, the mean serum iron of the control group decreased significantly between tests whereas that of the intervention group did not.

Therefore, a significant difference in iron status was apparent between groups at six months GCA, which did not exist at term. It is believed that, the improved iron status of the intervention group arose in response to a combination of early weaning (from three months),
the use of Nutriprem and the increased use of foods with a high iron content, such as meat, by
the intervention group compared with the control group.

The recognition that iron stores are quickly depleted by rapid growth (Sherriff et al., 1999),
that preterm infants have a high iron requirement (Griffin et al., 1999) and that iron deficiency
anaemia in infancy has a longer term negative influence on cognition (Morley & Lucas, 1997)
all underscore the importance of adequate iron status in infancy.

At the second blood test, the mean and standard deviation results for haemoglobin of the two
groups indicated that nearly half of the control group infants had a level at or below 11g/dl
(iron deficiency anaemia, IDA, is defined as Hb < 11g/dl, Sherriff et al., 1999), whereas less
than 10% of the intervention group were classified as IDA. Similarly, from the ferritin results
half of the control group infants were designated as having low iron stores (ferritin < 10 µg/l,
Gregory et al., 1995), whereas only 29% of intervention group infants had low ferritin levels
at six months GCA.

Hence, the improvement in iron status resulting from the preterm infant feeding strategy may
have very important benefits for growth and development.

4.5.iv. Comparison of Boys and Girls Blood Results

There were no gender differences in blood results at term or six months GCA, with the
exception of some of the selenium analyses. Here, the girls had a significantly higher mean
whole blood selenium level at term than boys and a significantly higher mean red blood cell
(RBC) selenium level at six months GCA than boys. Friel et al., (1993) similarly reported
improved selenium status in girls compared with boys in a study of VLBW infants.

RBC selenium levels and whole blood selenium levels are indicative of selenium status over a
longer time frame than plasma selenium values (Clayton & Round, 1994). It could be
hypothesised that boys have a higher physiological requirement for selenium than girls.

Hence, the plasma selenium levels, which reflected current dietary intakes, were similar for
both sexes but the whole and RBC selenium levels were lower for boys because of greater
metabolic need.

Alternatively, preterm girls may begin life with better selenium stores than preterm boys.
4.6 Growth

4.6.i. Growth Measurements of All Study Subjects
The growth of all study subjects was monitored by a consultant paediatrician for the study duration, no child was designated as 'failure-to-thrive' (downward deviation of weight gain trajectory, F. White, 1996) during the study. The growth of two infants, one from each group, was closely scrutinised throughout the study because of concerns in early infancy, which proved unfounded, about growth faltering. All other study subjects were judged clinically to have grown appropriately. No study subjects were diagnosed with any clinical condition, which could affect growth rates, for the study duration.

There were no significant differences between groups in measurements of growth, weight, length or head circumference, at any assessment point. Although not significantly different, the intervention group babies were shorter but older at the initial measurement point and younger at the final measurement point. These differences arose because of small variations in group characteristics and the four week range during which each anthropometric determination could be performed. The differences in mean ages at measurement points and in mean initial length determination may have masked valid differences in group end-points. The differing patterns of milk feeding, breast-feeding for more than six months, breast feeding for less than six months or formula feeding only, did not have any effect on final growth determinations. No confounding variables other than gender, such as social class or birth weight, which might affect growth, were uncovered during statistical analysis.

There were significant gender effects on growth. The boys had significantly larger heads at all assessment points and were significantly longer but not heavier at six and twelve months GCA. These differences were not unexpected.

4.6.ii. Growth Velocities of Study Subjects
The intervention group infants achieved a faster average length growth velocity between term and twelve months GCA compared with the control group, 5.1mm/week : 4.9mm/week, (p = 0.04). Similarly boys grew faster in length than girls, 5.1mm/week : 4.9mm/week, (p = 0.04). As, the sex ratio was the same in both groups, gender differences were not responsible for accelerated length growth in the intervention group. There were no significant differences in subject characteristics or family backgrounds between groups so it is concluded that the difference in feeding practices was the cause of the beneficial length growth rate differences.
The lack of significant group differences in weight or head circumference velocities between term and twelve months GCA indicates that the Preterm Infant Feeding Strategy (PIFS) did not noticeably affect those growth parameters.

Results in this study demonstrated different outcomes to that of Cooke et al (1998), who found significant improvements in length, weight and head circumference growth at six months GCA for boys only fed a preterm formula since birth compared with boys fed a standard infant formula. However, there were no breast-fed babies in that study.

4.6.iii. Growth Standard Deviation Scores of All Study Subjects

Nowadays, calculations of standard deviation scores (SDS) from growth measurements are used extensively, because they smooth out differences in growth patterns with time and due to gender. Figures 3.7.iv.a., b., and c. illustrate the variation in growth standard deviation scores during the course of the study. The improvement in values of length SDS and the change to a more normal distribution over time is clearly visible in fig. 3.7.iv.a. At term the mean SDS was −1.1, with a range from −5 to +2, whereas at twelve months GCA mean SDS was +0.1, with a range from −2.5 to +2.5.

The change in SDS (weight) over time demonstrated a similar but less dramatic improvement in mean values, from −1.5 to −0.7, but the distribution of individual values remained wide at one year GCA.

The change in the pattern of head circumference SDS over the course of the study was less reassuring. The mean SDS at term was close to zero, which may be considered to indicate that most subjects had appropriate head sizes at that time. The decrease in mean SDS by one year GCA may be evidence of inadequate head growth between term and twelve months GCA by a proportion of study infants. Hack et al, (1991b) have reported that for VLBW infants, perinatal growth failure and small head circumference at eight months of age are associated with poor cognitive function and poor academic achievement in childhood. Deleterious development sequelae for a proportion of study infants remain a possibility.

The increases in mean SDS for weight and length over the course of the study were significant \(p = 0.001\); the decrease in mean SDS for head circumference during the study was similarly significant \(p = 0.001\). These changes provide evidence for the occurrence of catch-up growth in length and weight for all study subjects during the study but not for head circumference.
It is noteworthy that mean SDS (weight) decreased between birth and term, confirming the assertion (Section 1.2.i.) that growth retardation often occurs in SCBU.

4.6.iv. Growth Standard Deviation Scores of the Intervention and Control Groups
Repeated measures ANOVA showed a significant effect due to group for length SDS \((p = 0.008)\) but not for weight SDS or head circumference SDS. This finding provides more evidence to support the beneficial effects of the Preterm Infant Feeding Strategy (PIFS). Surprisingly, there were no significant differences between groups in any growth standard deviation scores at the middle or final measurement points. The differences, though not significant, in SDS at term may have obscured any group effects.

4.6.v. Change in Growth Standard Deviation Scores of Study Subjects
To remove any variability in SDS due to age at measurement or initial size differences, the mean change in SDS for length, weight and head circumference were calculated.
The mean change in length SDS between term and six months GCA was significantly greater for the intervention group than the control group \((p = 0.0003)\). There were no significant changes in weight or head circumference SDS for this time interval between groups.
When the changes in growth SDS over the whole study duration were considered for all infants, there were no significant differences between groups. One possible inference from this lack of group effect over the whole study is that the length growth benefit is only short term. However, this contradicts the positive effects of PIFS over the whole course of the study reported in Sections 4.6.ii. and 4.6.iv.
Further statistical analysis revealed that there were some significant growth differences at six months GCA between babies who were breast fed for more than six months \((n = 7)\) and those who were not (Section 3.4ii.). For this reason, it was decided to exclude the long-term breast fed infants from a second analysis of growth SDS to provide a more homogeneous cohort.
The reduced subject cohort showed a significant difference in change in SDS (length) over the year \((p = 0.04)\). No significant group effects were detected for weight and head circumference SDS change.
This conclusion supports the view, previously expressed by other researchers (Lucas et al, 1997; Dewey et al, 1990), that formula-fed and breast-fed infants exhibit differing growth patterns.
4.6.vi. Catch-up Growth

Using the Avon Longitudinal Study of Pregnancy and Childhood's definition of catch-up growth (Ong *et al*, 2000), approximately two thirds of all subjects had achieved some catch-up length growth by twelve months GCA, sixty percent had achieved some catch-up weight growth by twelve months GCA but only nine percent had achieved some catch-up head circumference growth by twelve months GCA. The low rate of catch-up growth for head size was not unexpected as mean SDS (head circumference) at term was close to zero.

Significantly more intervention group subjects achieved some catch-up length growth by twelve months GCA than control group subjects (75% : 50%, *p* = 0.05). This result reinforces the beneficial effect on length growth of PIFS.

There were no group differences in rates of weight or head circumference catch-up growth and no gender differences in any type of catch-up growth.

4.6.vii. Body Proportions

The mean standard weight for height for all infants at all study measurement points was less than 100%. There was a trend for the mean standard weight for height to decrease over time for the intervention group children thus they were leaner at the end of the study than at the beginning whilst the mean standard weight for height of the control group children was unchanged over time. It may be inferred that the improved length growth performance of the intervention group subjects did not appear to have an associated commensurate weight growth enhancement, by the end of the study. Body composition data on all study subjects, which has not been analysed for this thesis, may reveal more information about the variations in body proportions within the study cohort.

As the mean standard weight for height remained above 90%, even for the intervention group infants, there was no concern that these children could be considered 'wasted'.

4.6.viii. Summary on Differences in Growth Performance between Groups

After other possible causative factors have been discarded (see 4.6.ii.), the increased length growth velocity by the intervention group compared with the control group, the significant effect due to group by repeated measures ANOVA for length SDS, the significant differences in mean increase in length SDS (reduced subject cohort) between groups and the significantly greater number of the intervention group demonstrating catch-up length growth compared
with the control group confirm the beneficial effects of the intervention group feeding regimen on length growth.

4.6.ix. Comparison of Growth Performance of All Study Infants with Other Published Results

Other researchers have published results of the growth performance of groups of LBW infants. Casey et al, 1991 recorded the growth measurements during infancy of 985 preterm infants, weighing less than 2.5 kg at birth and without any nutritional intervention, the range of results at twelve months GCA are presented in Table 4.6. Lucas et al, 1997 examined the growth performance of 54 SGA infants, comprising a breast fed and a formula fed group, the mean growth measurements of the two feeding groups are shown in Table 4.6. This study is included in the table because 43% of the current study infants were SGA and no differences were detected in their growth achievements compared to the AGA subjects in the study. Cooke et al, 1998 compared the growth of three groups of preterm infants, weighing less than 1.75 kg at birth, two of the groups received LBW formula after hospital discharge. The length, weights and head circumferences (HC) of the control group of 25 infants at six months GCA are reported in Table 4.6.

Table 4.6. The published growth measurements of LBW infants and the current study infants

<table>
<thead>
<tr>
<th>Study Measurement</th>
<th>Length (1)</th>
<th>Weight (1)</th>
<th>HC (1)</th>
<th>Length (2)</th>
<th>Weight (2)</th>
<th>HC (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Study</td>
<td>66.6</td>
<td>7.2</td>
<td>43.8</td>
<td>75.0</td>
<td>9.2</td>
<td>46.5</td>
</tr>
<tr>
<td>Mean (range)</td>
<td>(58.1-72.5)</td>
<td>(4.6-9.6)</td>
<td>(41.3-47.6)</td>
<td>(67.3-81.2)</td>
<td>(6.8-12.4)</td>
<td>(43.8-51.0)</td>
</tr>
<tr>
<td>Casey et al, 1991</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
<td>72.3-75.6</td>
<td>8.6-9.8</td>
<td>45.1-46.8</td>
</tr>
<tr>
<td>Lucas et al, 1997</td>
<td></td>
<td></td>
<td></td>
<td>73.1 : 72</td>
<td>9.0 : 8.6</td>
<td>45.5 : 45.3</td>
</tr>
<tr>
<td>Mean BF : FF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooke et al, 1998</td>
<td></td>
<td></td>
<td></td>
<td>65.3 : 63.7</td>
<td>6.9 : 6.6</td>
<td>43.7 : 43.2</td>
</tr>
<tr>
<td>Mean boys: girls</td>
<td></td>
<td></td>
<td></td>
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</table>

(1) measurement at 6 months GCA, (2) measurement at 12 months GCA. BF = breast fed group, FF = formula fed group.

The subjects in each of the published studies, cited above, had a different mean birth weight and mean gestational age, different inclusion criteria and experienced differing social and
nutritional environments to the subjects in the current study. However, when the published results of the other studies were compared with the lengths, weights and head circumferences (mean and range) of all the infants in this study, the comparison strongly supported the conclusion that infants in the current study (both groups) grew faster than LBW infants in general, who have experienced no nutritional intervention.

The designated 'control group' (B) in the current study, received nutritional guidance and advice from the researcher and hence could not be considered a 'true' control for the intervention group (A). The nutritional advice provided to Group B was based on the best currently available information at the start of the study. Thus, it could be inferred that both groups in the current study experienced a nutritional intervention. Although Group A achieved a greater length growth velocity than Group B, both groups appear to have achieved an average faster rate of weight, length and head circumference growth in infancy than LBW infants in comparable research studies.

4.7 Relationships between Growth, Dietary and Biochemical Results

4.7.i. Interactions between Dietary Intakes and Biochemical Variables

At Term: There were no apparent relationships between urea, iron, zinc and copper status of the study infants and dietary intakes of protein, iron, zinc and copper at term. One or more of the following factors may explain the lack of association between diet and biochemistry, at this point.

- The ranges of values for both the dietary intakes and the blood levels were wide.
- At this age (zero weeks GCA), not all infants will have achieved metabolic equilibrium.
- Preterm infants remain iron and zinc deficient for several months after birth (Tsang et al, 1993).

Hence, at term, preterm infants may have marginal stores of minerals. In addition, the infants' mean dietary intakes of protein and copper were below the current recommendations (Tsang et al, 1993) and would be unlikely to increase body stores. The strong homeostatic control of body zinc status renders a correlation with zinc intakes unlikely anyway, except at extremes of intake (Hunt & Groff, 1990).
At Six Months GCA: At the second assessment point, serum iron was significantly correlated with daily iron intakes and with iron intakes/kg of body weight. Serum iron reflects the current availability of iron to the tissues (as does serum ferritin), whereas haemoglobin levels tend to be conserved until a state of iron deficiency anaemia is reached (Hunt & Groff, 1990). Thus, the association between iron intakes and serum iron and the lack of association with haemoglobin are understandable, whilst the lack of association with serum ferritin levels is difficult to reconcile with these findings.

A correlation between zinc intakes and zinc status could not have been expected given the strong homeostatic control maintained on blood levels. Copper status in formula-fed infants may be more affected by the copper content of the water supply than by dietary intake (H.T. Delves, Trace Elements Specialist, personal communication). Hence, the lack of connection between copper intakes from food and milk and plasma copper levels becomes understandable.

As urea is the primary metabolic degradation product from surplus body protein (Polberger et al, 1990), the association between serum urea levels and protein intakes was unsurprising but pleasing to confirm.

4.7.ii. Interactions between Dietary Intakes and Growth

At Term: Lengths and weights were correlated with some indices of dietary intake at term. Both length and weight were significantly associated with daily intakes of protein, calcium, zinc and vitamins A and C. Additionally, weight was significantly correlated with energy, iron and copper intakes. The relationship between nutrition and growth is well established (Cooke & Embleton, 2000). In particular, protein and zinc intakes have been shown to be crucial determinants of growth for low birth weight infants in previous studies (Polberger et al, 1990; Friel et al, 1985). Hence, these relationships confirm the primary importance of adequate nutrition for growth.

Not surprisingly, dietary intakes did not influence head circumference measurements, which are more dependent on age than nutrition (Jelliffe, 1966).

There was an apparent negative association between lengths and weights at term and some measures of dietary intake/kg body weight at that point. These relationships could be construed as spurious because the effect may have been produced by vitamin and iron supplement usage. All significant correlations involved nutrients, which were consumed both in the diet and in vitamin and mineral supplements by the majority of infants at term. In the
diet of each infant, the majority of whom were consuming supplements, the contributions of iron, vitamin A and vitamin C from the supplements were larger than those from baby milks. Nearly all babies were prescribed the same dosage of supplements, hence, lighter, shorter babies were consuming greater amounts of these nutrients/kg body weight than heavier, longer babies.

**At Six Months GCA**: By six months GCA, the number of significant associations between nutritional intake and growth indices had decreased. This may be a consequence of the reduction, between term and six months GCA, in infant growth rates or improved nutritional intakes at this point, or both. However, the pre-eminence of protein and zinc as length growth promoters remained. Copper intakes were also significantly correlated with length growth and protein intakes with weights. It may be concluded that levels of protein intakes and the intakes of some minerals remain crucial to growth promotion at this stage of infancy.

No other associations were detected, with the exception of a significant, negative correlation between energy intakes/kg body weight and body weights. This unexpected finding may result from the non-linear growth patterns commonly demonstrated by preterm infants (Casey et al., 1991). Infants with higher energy intakes/kg body weight but lower body weights may be beginning a growth spurt, whilst infants consuming less energy/kg body weight may have just completed a growth spurt and in consequence have gained weight.

The significant connection between 'early' weaning and length growth, apparent at this point in the study, is indicative of the inability of human milk or standard formula alone to supply adequate amounts of some nutrients to foster optimum growth in preterm infants after hospital discharge (Cooke et al., 1998; Lucas et al., 1992a).

**At Twelve Months GCA**: Only three significant correlations linking diet and growth were identified from the assessments at twelve months GCA. Weights at twelve months GCA were again negatively correlated with energy intakes. The explanation offered for this association at six months GCA may also be valid at this point.

Iron intakes were correlated with head circumferences at twelve months GCA. This finding is particularly noteworthy, when the importance of iron sufficiency for mental and psychomotor development (Williams et al., 1999) and the rate of iron deficiency anaemia (12% amongst toddlers, Gregory et al., 1995) are taken into account.

As at six months GCA, there was a significant connection between 'early' weaning and length growth at the end of the study. This continuing, significant association underlines the beneficial growth effects of the Preterm Infant Feeding Strategy on length growth.
4.7.iii. Interactions between Biochemical Variables and Growth

At Term: Lengths and weights were significantly correlated with serum urea levels at term. As serum urea levels reflect protein intakes (Polberger et al, 1990), this association confirms the importance of protein supply for growth promotion. The correlation between copper intakes at term and head circumferences is not readily explained. This may be a chance finding or it is possible that copper may be the limiting nutrient for brain enlargement at this point but not for somatic growth.

At Six Months GCA: Although length at six months GCA was correlated with zinc and copper intakes, an association between length and mineral plasma levels could not have been expected, given the strict homeostatic control of body zinc and the absence of evidence of a relationship between growth and body copper levels.

4.7.iv. Interactions between Dietary Intakes and Growth throughout Infancy

The variation in intakes/kg body weight of energy, protein, calcium and copper significantly affected one or more different measures of growth performance over the year of the study. In addition, for calcium alone, total daily intakes were associated with SDS length change between term and twelve months GCA and weight growth rate between term and twelve months GCA.

From the evidence of a relationship between calcium intakes, both total and /kg body weight, and length and weight growth, it could be inferred that the supply of calcium, was marginal or inadequate for a number of infants throughout infancy. However, the lack of significant correlations between intake and growth at assessment points provided little support for the crucial role of calcium in growth promotion. Calcium intakes were only sufficiently critical at term, to be significantly correlated to measurements of weight but not length or head circumference, at the other two assessment points no significant correlations with growth variables were apparent.

Protein intakes/kg body weight were significantly related to length and weight growth performance over the course of the study and protein intakes were linked to length and weight growth at both term and six months GCA. These interactions provide strong support for the contention that protein is a critical growth promoter.

The relationship between energy intakes and growth performance is less clear cut. Energy intakes/kg body weight and weight and head circumference growth rates appeared from the Repeated Measures analysis of variance to be significant, whereas bivariate correlations
produced significant associations between energy intakes and lengths at term only, but negative associations between energy intakes/kg body weight and weights at six and twelve months GCA, only.

Similarly, the existence of a relationship between copper intakes/kg body weight and weight growth rate must be viewed with scepticism in the light of the absence of a significant correlation between copper intakes and weights at any of the three measurement points. Except for the consistent relationship between protein intakes and growth performance and possibly, that of calcium intakes and growth rates, the influence of other dietary components on growth is far from persuasive. It may be speculated that different nutrients are critical growth promoters at different stages in infancy or that in later infancy the majority of infants were receiving adequate supplies of all nutrients. The dietary analyses at twelve months GCA support the latter hypothesis.

In general, the interactions between growth and nutritional intakes are complex and not fully elucidated, while the relationship between growth and nutritional intakes for preterm infants remains even more obscure. The interpretation of apparent relationships between energy and nutrient intakes with length, weight and head circumference growth velocities must be viewed cautiously.

4.8 Energy and Nutrient Requirements of Preterm LBW Infants

The demonstrated length growth benefits, accruing to infants in the intervention arm of this study, substantiated the claim that the Preterm Infant Feeding Strategy (Section 2.1) more nearly met the energy and nutrient requirements of those infants after hospital discharge than the current feeding practices adopted for the control group infants.

The dietary analyses at six months and twelve months GCA of the intervention group food diaries provided specific mean intakes for energy, macronutrients, several minerals and vitamin C of well growing infants born preterm at the two ages of six months and twelve months GCA. The analyses are evidence, not otherwise available, of the intakes of healthy infants born preterm, the majority of whom were achieving catch-up growth in length and weight.
These results could be used in conjunction with Recommendations for Stable, Growing Preterm Infants (Tsang et al, 1993), to extend nutritional recommendations for preterm LBW infants up to one year GCA.

One of the contentions of this thesis is that the mean intakes, from the dietary analyses, should be adopted as the energy and specified nutrient requirements for preterm LBW infants at six months and twelve months GCA. These recommendations are summarised in Table 4.8.

Caution must be exercised with respect to the mean daily protein intake and mean daily sodium intake at twelve months GCA. The protein and sodium intakes were almost certainly in excess of need, and were a consequence of food choices. A useful method of assessing protein requirements for preterm LBW infants at this age would be to use the PER for catch-up growth, i.e. 11% (Jackson & Wootton, 1989). Alternatively, the protein and sodium intakes from six months GCA might be a more appropriate guide to requirements at twelve months GCA.

Table 4.8. Energy and nutrient intakes of preterm infants at 6 & 12 Months GCA

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Six Months GCA</th>
<th>Twelve Months GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total /kg /100kcal</td>
<td>Total /kg /100kcal</td>
</tr>
<tr>
<td>Energy</td>
<td>kj (kcal)</td>
<td>3442 (823) 477 (114)</td>
<td>4213 (1007) 462 (111)</td>
</tr>
<tr>
<td>Protein</td>
<td>g</td>
<td>26.7 3.7 3.2</td>
<td>36.5 4.0 3.6</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>g</td>
<td>108.3 15.0 13.2</td>
<td>128 14.0 12.7</td>
</tr>
<tr>
<td>Fat</td>
<td>g</td>
<td>32.3 4.5 3.9</td>
<td>40.9 4.5 4.1</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg</td>
<td>436 61 53</td>
<td>988 108 98</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>751 104 91</td>
<td>801 87 80</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg</td>
<td>561 78 68</td>
<td>844 84 84</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>12.9 1.8 1.6</td>
<td>9.2 1.0 0.9</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>5.6 0.8 0.7</td>
<td>5.4 0.6 0.5</td>
</tr>
<tr>
<td>Copper</td>
<td>µg</td>
<td>481 66 58</td>
<td>435 48 43</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>133 19 16</td>
<td>87 10 9</td>
</tr>
</tbody>
</table>
4.9 Main Avenues of Future Work

4.9.i. Further Anthropometric Measurements and Body Composition Analysis
Ideally, in an anthropometric study of children, further determinations of body size, such as mid-arm circumference, chest circumference, skinfold thicknesses, crown to rump length and/or knee to ankle length, would be elicited. Practical considerations, the appropriateness of the anthropometric determinations for that age group, and parents' wishes may reduce the range of obtainable measurements. In the present study, further observations were made but the options were limited by the difficulties of assessing either very small babies or wriggly, uncooperative older infants. In the present study, mid-arm circumference, triceps and subscapular skinfold thicknesses were determined for all infants at all assessment points. At some further date, it is hoped to establish a comparative determination of body fatness between groups and changes in body fatness over time from these additional anthropometric data.

4.9.ii. Developmental Testing of Study Subjects
The interrelationship between growth and development, the increased likelihood of delay in mental and motor development of preterm infants and the fact that nutrition after birth has been shown to affect the development of preterm infants in some instances (Lucas et al, 1994b) argued for the developmental assessment of the study subjects. However, no objective, reliable method of assessing development was found for children until after the gestation corrected age of one year. Developmental testing at eighteen months GCA should demonstrate any beneficial effects upon development in the areas of speech, language, motor skills and social skills that the preterm infant feeding strategy produced in the study infants. Developmental tests are currently being conducted by a psychologist working for the Child Clinical Psychological Services, Winchester and Eastleigh Healthcare Trust. The testing procedure is supervised by Mr Peter Crowley, Principal Clinical Psychologist, Head of Speciality, Children and Families. After informed, written parental consent is obtained, each child is tested once at age eighteen months GCA and will be retested, if practical, at around three years of age GCA.
The Bayley Scales of Infant Development II are used to assess each child’s progress. These scales are an internationally recognised method of evaluating child development. The scales assess three areas of development:

- **The Mental Scale** assesses a child’s current level of cognitive development, language skills and personal-social development.
- **The Motor Scale** identifies a child’s fine and gross motor development. This gives a measure of a child’s muscle control and co-ordination.
- **The Behaviour Rating Scale** reflects a child’s behaviour during the test.

The testing procedure is performed in the child’s home environment and comprises a graduated set of simple tasks. The scores for each study subject will be used to assess the overall and group means for each developmental scale and to determine any associations between nutrient intakes, growth or mineral status with development level. In addition, the psychologist provides an assessment of each child’s current abilities and their general level of motor, mental and social development to the parents.

### 4.9.iii. Allergy Testing of Study Subjects

Research into the causes of increasing rates of allergic disease amongst children in the last few decades have occasionally implicated aspects of weaning practice (Wilson *et al.*, 1998), specifically the introduction of solid foods before four months of age.

Individuals with an atopic disposition may or may not develop one or more of the following conditions: asthma, hay fever, eczema or allergic rhinitis. Atopy, which is known to be familial, is usually associated with high circulating levels of Immunoglobulin E (IgE) in response to common environmental allergens. 'At-risk' infants are those born into atopic families. The incidence of clinically diagnosed atopic disease in children is approximately 20-35% and rising.

The study contention is that the early introduction of solid (complementary) foods does not subsequently lead to an increased risk in the development of allergic symptoms in preterm infants when assessed at 18 months gestation corrected age if feeding guidelines were given to the parents containing information about the most appropriate non-allergenic solid foods to give to their infants.
Allergy testing would determine if there are detrimental effects associated with the early introduction and use of appropriate types of complementary food on the incidence of atopic disease in preterm infants when assessed at 18 months gestation corrected age. The levels of atopy and prevalence of allergic diseases amongst study subjects are currently under investigation. Three primary outcome measures are employed to determine levels of atopy and prevalence of allergic diseases amongst study subjects.

1. Total and allergen specific Immunoglobulin E (Radioallergosorbent serological screening testing).
2. Results from skin prick tests to the most common allergens.

Children enrolled in the main study are assessed for allergies at eighteen months past their expected date of delivery, i.e. between 19-22 months of age. The parents who consent to the allergy testing of their child receive an assessment of the child’s atopic status and the name(s) of any substances to which their child has shown a positive allergic reaction.

Data obtained from the allergy investigation will provide strong scientific evidence for any effect of early weaning on the risk of atopic disease in preterm infants. In addition, the prevalence of atopic diseases among subjects in the main study with a birth weight appropriate for gestational age (AGA) compared to those born small for gestational age (SGA) will be assessed. This will allow for a test of the hypothesis that adverse pregnancy outcome, i.e. being born SGA, is associated with the T- Helper Cell phenotype TH1 (non-allergenic) rather than T- Helper Cell phenotype TH2 (allergenic) (Raghupathy, 1997).

4.9.iv. Patterns in Food Consumption Practices for Infants Born Preterm

The parents were requested to report details of all foods consumed by their infant as fully as possible. From the food diaries it should be possible to examine information about the types and patterns of foods offered to preterm infants at six and twelve months GCA. A further analysis of the food diaries would provide data for comparisons of preterm infant feeding practices with those of full-term infants of the same gestation corrected ages.

4.9.v. Anthropometric Measurement in Childhood

It would be particularly useful to follow the growth patterns of the study children throughout early childhood and beyond. The longevity of the improved length growth performance of the intervention group children could then be established.
To do this would necessitate repeat measurements of length, weight and head circumference at the same specified gestation corrected ages for all subjects. It is hoped to perform at least one set of measurements at three years GCA.

4.9.vi. Further Research
A longer term, more comprehensive study, with a larger number of subjects, incorporating the preterm hypothesis and a further intervention with respect to milk feeding for bottle-fed infants should be undertaken to confirm:
- the positive length growth results from the existing study,
- the possibility of weight and head circumference catch-up growth,
- the developmental sequelae of the feeding regimen.

4.10 Conclusions
In the absence of any existing nutritional guidelines for preterm infants after hospital discharge, the results of this study substantiate the claims of other researchers (Cooke et al, 1998; Lucas et al, 1992a) that preterm LBW infants have different nutritional requirements to those of full-term infants for up to one year GCA. Primarily, the study provided evidence of enhanced length growth, increased dietary intakes and improved iron status for infants being fed in accordance with the Preterm Infant Feeding Strategy (PIFS). The study regimen was well received by the parents of preterm LBW infants and the feeding guidelines were correctly interpreted and carefully executed by them.

The impetus for the study was reinforced by dietary analyses of milk intakes within a week or two of hospital discharge. These showed that, as a group, the study subjects were failing to achieve protein and mineral intakes commensurate with optimum growth at that point. Furthermore, limited intestinal capacity notwithstanding, increased volume intakes of either human milk or standard formula would have been unable to overcome the protein deficit because the PERs of human milk and standard infant formula milks are below the minimum level required for catch-up growth.

The beneficial effects of the PIFS were apparent by six months GCA, when solid feeding was well established for the intervention group. At this stage of the study, infants in the intervention group were consuming more than the age appropriate EAR for energy and in
excess of the RNI for all other nutrients. Obviously, increasing the nutrient density of the
infant diet with the early introduction of energy and nutrient dense solid foods surmounted the
problem of limited stomach capacity and provided at least adequate quantities of nutrients.
The mean dietary intake results at six and twelve months GCA provided valuable information
about the nutritional requirements of preterm LBW infants at those ages.
It could be argued that the energy and nutrient density of the formula milk fed to bottle-fed
babies after hospital discharge could be easily, if expensively, increased as an alternative to
'early weaning'. However, this practice would not be feasible for preterm breast-fed babies,
who would remain nutritionally disadvantaged. The Preterm Infant Feeding Strategy benefits
breast-fed and formula-fed infants equally.
The following five trenchant observations arose from this study.
Firstly, the mean length growth velocity of infants being fed according to the
recommendations in the Preterm Infant Feeding Strategy was significantly greater than the
mean length growth velocity of infants being fed according to the Department of Health
recommendations for full-term infants (DoH, 1994).
Secondly, an analysis of the mean growth patterns of the intervention group infants
demonstrated an eradication of length growth retardation and a reduction in weight growth
retardation during the course of the study.
Thirdly, the mean intakes of energy, protein and carbohydrate at six months GCA and their
mean intake of iron at twelve months GCA were significantly higher for the intervention
group compared with the control group infants at those ages.
Fourthly, the intervention group infants had better iron status, as measured by mean
haemoglobin and mean serum iron levels, at six months GCA compared with the control
group infants. This result may have important ramifications for both growth and development.
Finally, the supine lengths at six and twelve months GCA correlated significantly with the age
at the first introduction of solid foods.
In conclusion, the contention of this thesis is that the recommendations in the Preterm Infant
Feeding Strategy should be adopted for use as the feeding guidelines for preterm LBW infants
after hospital discharge up until one year GCA to promote optimum length growth, without
disadvantaging weight or head circumference growth patterns.
An adapted form of the strategy, outlined in this thesis, could be produced and promulgated. It
would include the following provisions:
1. Human milk and/or a suitable infant formula milk (chosen after advice from relevant healthcare professionals) will be used as the sole food until the infant is ready for weaning.

2. Preterm infants will be introduced to semi-solid foods from around 13 weeks of postnatal age, provided the infant weighs at least 3.5 kg, the parents detect signs of weaning readiness and that the baby is past his/her expected date of delivery.

3. The energy density of suitable baby foods, whether home prepared or commercial foods, should be in the range 300-450 kJ/100g, (70-105 kcal/100g).

4. The protein content of suitable baby foods should be in the range of 2.3-5.0 g/100g for cereal and savoury foods, and 1.0-4.0 g/100g for fruit puddings and other desserts. Recipes would be provided for home prepared dishes.

5. The major contributory solid foods to the infant diet should be cereals, potatoes and other starch rich, low fibre vegetables and pulses, meat, fish and a limited quantity of cheese.

6. Weaning foods (home prepared and/or commercial baby foods), which comply with the energy and protein densities outlined above, should be introduced in the following order:
   - Baby rice + human or formula milk and/or alternative cereal/ baby milk mixes;
   - Potato and vegetable purées with baby milk and/or commercial vegetable baby foods;
   - Puddings with or without fruit;
   - Cheese (up to 10g/day until 9 months of age), yoghurt and salt free butter as constituents of savoury or pudding meals;
   - Meat and/or vegetable and/or pulse mixes, with baby milk and/or commercial baby foods, which contain meat;
   - Fish and vegetable mixes with baby milk and/or commercial baby foods, which contain fish.

7. Follow-on milk will be introduced at 8 months of postnatal age to bottle-fed infants. This or breast milk will be the main drink until one year of Gestation Corrected Age (GCA).

8. Guidelines to parents on the varieties and combinations of weaning foods, which are appropriate for each stage of weaning, will be suggested.
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APPENDICES

I Nutrient Recommendations for Preterm Infants
II Determination of Achievable Growth Outcomes
III Study Information Letters and Parental Consent Form
IV Suitable Commercial Baby Foods for the Intervention Group
V Set of Feeding Guides for the Intervention Group
VI Set of Feeding Guides for the Control Group
VII Milk Diaries for Breast and Bottle-fed Infants
VIII Food Diary
IX Nutriprem Information Leaflet
X Blood Sampling Protocol
XI Ethics Approvals
### APPENDIX I

#### Nutrient Recommendations for Preterm Infants

<table>
<thead>
<tr>
<th>Nutrient (unit)</th>
<th>Tsang(^1) /kg body wt</th>
<th>DRV(^2) (0 months)</th>
<th>DRV(^2) (6-9 months)</th>
<th>DRV(^2) (10-12 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kj)</td>
<td>460-503</td>
<td>480 kj/kg *</td>
<td>400kj/kg *</td>
<td>400kj/kg *</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>3.0 - 3.8</td>
<td>12.5</td>
<td>13.7</td>
<td>14.9</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>46-69</td>
<td>210</td>
<td>320</td>
<td>350</td>
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<tr>
<td>Potassium (mg)</td>
<td>78-120</td>
<td>800</td>
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</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>60-140</td>
<td>406</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>120-230</td>
<td>525</td>
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<td>525</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>2</td>
<td>1.7</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>1.0</td>
<td>4.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Thiamin (mg)</td>
<td>0.18-0.24</td>
<td>0.3/4,184 kj</td>
<td>0.3/4,184 kj</td>
<td>0.3</td>
</tr>
<tr>
<td>Vitamin A (µg)</td>
<td>210-450</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>18-24</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Vitamin D (µg)</td>
<td>3.8-10</td>
<td>8.5</td>
<td>7</td>
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</tr>
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</table>

\(^1\) The Tsang recommendations are quoted per kg of body weight, the Dietary Reference Value (DRV)\(^2\) are quoted as total daily intakes with the exception of energy.

\(^2\) The reference nutrient intake (RNI) is shown as the Dietary Reference Value (DRV) for all nutrients except for energy, where the estimated average requirement (EAR) /kg body weight is quoted.

**References**


APPENDIX II

Determination of Achievable Growth Outcomes at One Year GCA

1 Dr Kovar’s opinion :-

Increase in centile position of 5-10 points.
Calculations of growth outcomes arising from this.

<table>
<thead>
<tr>
<th>Wt.(kg)</th>
<th>L. (cm)</th>
<th>H.C. (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For boys from 0-1 year pt:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd→9th centile =</td>
<td>0.55</td>
<td>1.6</td>
</tr>
<tr>
<td>9th + 10 centile points =</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>25th+10 centile points =</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

For girls from 0-1 year pt:
<table>
<thead>
<tr>
<th>Wt.(kg)</th>
<th>L. (cm)</th>
<th>H.C. (cm)</th>
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</thead>
<tbody>
<tr>
<td>2nd→9th centile =</td>
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<tr>
<td>9th + 10 centile points =</td>
<td>0.4</td>
<td>0.9</td>
</tr>
<tr>
<td>25th+10 centile points =</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

2 Dr Foote’s opinion :-

Increase in expected gain over one year of:

<table>
<thead>
<tr>
<th>Wt.(kg)</th>
<th>L. (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>1</td>
</tr>
<tr>
<td>0.26</td>
<td></td>
</tr>
</tbody>
</table>

3 From References with a Nutritional Intervention:-

- Lucas, 1992a

Approximate increase in values (centiles) for a group fed enriched formula vs standard formula from 0-40 weeks post term.

For boys and girls:

<table>
<thead>
<tr>
<th>Wt.(kg)</th>
<th>L. (cm)</th>
<th>H.C. (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 (10→25)*</td>
<td>1.6 (25→50)*</td>
<td>0.5(50→65)*ns</td>
</tr>
</tbody>
</table>

- Cooke, 1996

Increase in values for a group fed enriched formula vs standard formula from 0-26 weeks post term.

<table>
<thead>
<tr>
<th>Wt.(kg)</th>
<th>L. (cm)</th>
<th>H.C. (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For boys:</td>
<td>1.2**</td>
<td>1.6**</td>
</tr>
<tr>
<td>For girls:</td>
<td>0.4**</td>
<td>0.6**</td>
</tr>
</tbody>
</table>
From References with Observational Growth Data:-

- Ernst, 1990

Differences in growth according to sex/Aga/SGA, for VLBW infants. Greatest growth velocity recorded for AGA girls, 0-1 year pt. Approximate increases in values:

\[
\begin{array}{ccc}
\text{Wt.(kg)} & \text{L. (cm)} & \text{H.C. (cm)} \\
0.8 (5\rightarrow25)^* & 2 (10\rightarrow30)^* & 0.6 (25\rightarrow40)^*
\end{array}
\]

- Friel, 1985

Differences in growth according to sex. Boys, only, changed centiles for length only.

\[
\begin{array}{ccc}
\text{Wt.(kg)} & \text{L. (cm)} & \text{H.C. (cm)} \\
- & 1.0 (5\rightarrow10) & -
\end{array}
\]

- Casey, 1991

Growth Achievement between 0-1 year post term, for three groups of LBW infants. I, ≤1250g, II, 1251-2000g, III, 2001-2500g.

\[
\begin{array}{ccc}
\text{Wt.(kg)} & \text{L. (cm)} & \text{H.C. (cm)} \\
\text{I, II, III} & \text{I, II, III} & \text{I, II, III} \\
\text{For boys:} & 6.2, 6.3, 6.3 & 27.2, 25.9, 24.8 & 11.7, 11.4, 11 \\
\text{For girls:} & 5.9, 5.9, 5.9 & 26.3, 24.9, 23.9 & 11.0, 10.6, 10.6
\end{array}
\]

Centile Growth Values:-

Growth Increase between 0-1 year post term for infants following 0.4 and 50th centiles:

\[
\begin{array}{ccc}
\text{Wt.(kg)} & \text{L. (cm)} & \text{H.C. (cm)} \\
0.4, 50 & 0.4, 50 & 0.4, 50 \\
\text{For boys} & 5.3, 6.6 & 23.3, 24.5 & 12.8, 12.7 \\
\text{For girls} & 5.1, 6.3 & 22.6, 23.8 & 9.7, 10.9
\end{array}
\]

The differences in growth parameters at 1 year p.t.between the 0.4 & 50th, and 0.4 & 99.6th centiles are:

\[
\begin{array}{ccc}
\text{Wt.(kg)} & \text{L. (cm)} & \text{H.C. (cm)} \\
\text{For boys} & 2.5, 5.7 & 6.7, 13.5 & 3.2, 7.3 \\
\text{For girls} & 2.2, 5.3 & 6.3, 12.7 & 3.1, 6.1
\end{array}
\]

* Italised figures in brackets refer to average, approximate centile change, as determined from result graphs.

** Mean values with large S.D.s.
A comparative study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants

Dear Parent,

We are writing to ask you to consider helping us in a clinical study being carried out at this hospital and the University of Surrey. The study aims to find the best way of feeding babies like yours, after they leave hospital.

Preterm babies may have different feeding needs, especially when solid foods begin to be introduced, compared to babies born full-term. It is very important that preterm babies receive enough of all the right nutrients, such as carbohydrates, protein, vitamins and minerals to allow proper growth. This study hopes to give precise details to doctors, nurses and parents about how to best feed these babies, after they leave hospital.

If you join the study, your baby’s growth and nutrition will be followed by us for one year, from the expected date of delivery of your baby. Each baby will be weighed and measured three times - at the start, in the middle, and at the end, of the year. At the beginning and end of the study, a very small amount of blood, (half of a teaspoonful) will be removed by Dr Foote, after a local anaesthetic has been applied. As far as possible blood testing will be performed in conjunction with routine follow-up tests, and you may refuse this if the sample is not required for medical purposes. You will also be asked to fill in, in a special diary, what your baby eats for one week. You will need to do this three times in all.
All the information about your baby’s growth, food intake and blood measurements will be available to you, if you would like it. In addition, each family will be given a booklet to guide them through the introduction of solid foods to their baby. Advice from the nutritionist will be available to you at all times, if you require it.

Please be assured that all information is treated anonymously and in the strictest confidence. Your name and address will not be used by us, except to visit you to measure your baby and to send you information about the research. Your name and address will not be passed to anyone else.

Please feel free to discard this letter if you do not want to consider this matter any further. Please be assured that there are no disadvantages to you or your baby in doing that.

If you have any questions about the study, or would like to discuss it more fully, please ring Lynne Marriott (Study Nutritionist) on 01962 620975 or speak to Dr Keith Foote in the Special Care Unit. The Winchester Research Ethics Committee has approved this study.

We realise looking after a new baby is very time consuming and tiring, and parents of preterm babies may have extra worries and stress. However your help in this research would be very much appreciated, and we would endeavour to offer you every support throughout the study. You should be reassured that if you do join the study, you may withdraw at any time without giving a reason or incurring any disadvantage to yourself or your baby.

If you would like to consider joining the study, please let Dr Keith Foote or the Nurse in Charge in the Special Care Baby Unit know, or ring 01962 620975. More information will be provided by Lynne Marriott, who will arrange to speak to you, at your convenience.

This will not commit you to join the study, only to further consideration about it.

Yours sincerely,

Dr Keith Foote                                      Mrs Lynne Marriott
2. Parent Consent Form

I

______________________________________________-(Full Name)
of

______________________________________________-(Address)

hereby fully and freely consent to my child

______________________________________________-(Full Name)

participating in a clinical trial entitled:

* A comparative study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants *

I agree that my family’s general practitioner is notified of the participation of my child in the study.

I understand and acknowledge that the investigation is designed to promote medical and nutritional knowledge.

I understand that I may withdraw my child from the study at any stage in the investigation. I acknowledge that I understand the purpose of the investigation and any risks involved from the procedures. The nature and purpose of such procedures has been detailed to me in an information sheet and has been explained to me by:

Mrs Lynne Marriott and Dr Keith Foote

and I have discussed these matters with them.

Signed

______________________________________________- (Parent)

Witness

______________________________________________- (Signature)

______________________________________________- (Name)

______________________________________________- (Address)

Date

______________________________________________

DECLARATION BY INVESTIGATORS

We confirm that we have provided an information sheet and explained the nature and effect of the procedures to be used and that consent has been given freely and voluntarily.

Signed

______________________________________________

Consultant Paediatrician

______________________________________________

Research Nutritionist
3. General Practitioner Information Letter

Date

_A comparative study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants_

Dear Doctor

The ideal long-term nutritional regimen for low birth weight preterm babies to promote normal development, and allow catch-up growth, where necessary, has not been sufficiently investigated. Some evidence suggests that preterm infants, throughout the first year of life, may have higher energy and protein needs per kg of body weight than those of their normal birth weight counterparts. Some specific nutrients, such as long chain polyunsaturated fatty acids, zinc, iron, calcium and selenium may be of particular importance for catch-up growth in these children.

A randomised, comparative study of preterm infants is being conducted by Lynne Marriott, School of Biological Sciences, University of Surrey, and Dr Keith Foote, Consultant Paediatrician, Royal Hampshire County Hospital. The study will evaluate the growth, mineral status and nutrient intakes of two groups of preterm infants from shortly after birth for one year. One group will be given solid feeding guidelines, which conform to best, current practice. The other will be given guidelines, which will feature baby foods with an enhanced energy, protein and mineral content. Weight, supine length, head circumference and skinfold thickness will be measured three times during the study. Three (7-day weighed intake) diet diaries and simple monthly food frequency tick lists will need to be completed by a parent. A small blood sample (2.5ml) will be taken by venepuncture at the beginning and end of the study.

The objective of the study is to produce a nutritional strategy for preterm infants for the introduction of solid foods, i.e. for the weaning process, which will promote optimum growth and development. The strategy will cover the period from after hospital discharge until one year of age and will be translated into practical feeding guidelines for mothers to follow.
We are writing to inform you that parental consent has been obtained for one of your patients to join the study.

Your patient ............................................................................................................................ (Name)
............................................................................................................................ (Address)
............................................................................................................................
............................................................................................................................ (D.O.B.)

has been enrolled in the study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants.

RESEARCH TEAM
Clinical Investigator
Dr Keith Foote
RHCH

Research Investigator
Mrs Lynne Marriott
University of Surrey

Project Co-ordinators
Dr JB Morgan, Dr JT Bishop
University of Surrey

Please could you inform the clinical investigator, Dr Foote, of any reservations you may have concerning the inclusion of your patient (named above) in the research study.

Please reply to:-
Dr Keith Foote
Paediatric Dept.
Royal Hampshire County Hospital
Romsey Road
Winchester SO22 5DG.

Thank you for your co-operation in this matter.

Yours sincerely,

Dr Keith Foote

Mrs Lynne Marriott
4. Health Visitor Information Letter

Dear Health Visitor

We wish to inform you that __________________________

has been enrolled in:

*A comparative study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants.*

This is a randomised, comparative study of preterm infants being conducted by Dr Keith Foote, Consultant Paediatrician, Royal Hampshire County Hospital and Lynne Marriott, School of Biological Sciences, University of Surrey. The study will evaluate the growth, mineral status and nutrient intakes of a group of preterm infants from shortly after birth for one year. The parents will be given specific solid feeding guidelines, which conform to best, current practice and/or the advice of senior academic nutritionists/dietitians. The guidelines will feature baby foods with an enhanced energy, protein and mineral content and will give parents information about when to begin weaning and the preparation of suitable baby foods. Weight, supine length, head circumference and skinfold thicknesses will be measured three times during the study. Three (7-day weighed intake) diet diaries and simple monthly food frequency tick lists will need to be completed by a parent. A small blood sample will be taken by venepuncture at the beginning and at a later point in the study.

The aim of the study is to produce a nutritional strategy for preterm infants for the introduction of solid foods, i.e. for the weaning process, which will promote optimum growth and development. The strategy will cover the period from after hospital discharge until one year of age and will be translated into a practical feeding scheme for parents to follow.

The study has been discussed with Name, Health Visitor Manager, District Health Trust. Please call Lynne Marriott 01962 620975 if you would like further information about the study and/or the feeding guidelines. Copies of a Health Visitor Information Sheet, the Study Protocol and the Feeding Guidelines are held in the Health Visiting Services District Office.

Thank you for your co-operation in this matter.

Yours sincerely

Mrs Lynne Marriott  
Dr Keith Foote
## Suitable Commercial Baby Foods for the Intervention Group

### i. Cereal and Breakfast Foods

<table>
<thead>
<tr>
<th>Company</th>
<th>Name</th>
<th>Type</th>
<th>Energy (kJ)</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow &amp; Gate</td>
<td>Creamed Porridge</td>
<td>p</td>
<td>453</td>
<td>5.2</td>
</tr>
<tr>
<td>Milupa</td>
<td>Creamed Porridge Oats</td>
<td>p</td>
<td>409</td>
<td>4.6</td>
</tr>
<tr>
<td>Farleys</td>
<td>Original Rusks</td>
<td>dry</td>
<td>1680</td>
<td>6.6</td>
</tr>
<tr>
<td>Heinz</td>
<td>Apple &amp; Banana Cereal</td>
<td>P</td>
<td>386</td>
<td>2.8</td>
</tr>
<tr>
<td>Boots</td>
<td>Banana Breakfast</td>
<td>P</td>
<td>435</td>
<td>3.5</td>
</tr>
<tr>
<td>Boots</td>
<td>Porridge Breakfast</td>
<td>p</td>
<td>455</td>
<td>3.0</td>
</tr>
</tbody>
</table>

### ii. Vegetable Foods

<table>
<thead>
<tr>
<th>Company</th>
<th>Name</th>
<th>Type</th>
<th>Energy (kJ)</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow &amp; Gate</td>
<td>Vegetable Casserole</td>
<td>P</td>
<td>325</td>
<td>3.0</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Summer Vegetable</td>
<td>P</td>
<td>364</td>
<td>3.4</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Highland Vegetable &amp; Cheese</td>
<td>j</td>
<td>352</td>
<td>3.5</td>
</tr>
<tr>
<td>Milupa</td>
<td>Vegetable Hotpot</td>
<td>p</td>
<td>403</td>
<td>3.2</td>
</tr>
<tr>
<td>Milupa</td>
<td>Cauliflower &amp; Cream Potato</td>
<td>P</td>
<td>434</td>
<td>4.1</td>
</tr>
<tr>
<td>Farleys</td>
<td>Cauliflower &amp; Broccoli Cheese</td>
<td>P</td>
<td>436</td>
<td>4.0</td>
</tr>
<tr>
<td>Farleys</td>
<td>Leek &amp; Potato Pie</td>
<td>P</td>
<td>422</td>
<td>3.5</td>
</tr>
<tr>
<td>Farleys</td>
<td>Mediterranean Vegetable &amp; Rice</td>
<td>P</td>
<td>432</td>
<td>4.0</td>
</tr>
<tr>
<td>Heinz</td>
<td>Cream Potato &amp; broccoli</td>
<td>J</td>
<td>315</td>
<td>3.2</td>
</tr>
<tr>
<td>Boots</td>
<td>Cauliflower &amp; Potato Bake</td>
<td>P</td>
<td>426</td>
<td>3.5</td>
</tr>
<tr>
<td>Hipp</td>
<td>Spinach, Potato &amp; Cheese</td>
<td>j</td>
<td>302</td>
<td>3.8</td>
</tr>
</tbody>
</table>

### iii. Puddings with or without Fruit

<table>
<thead>
<tr>
<th>Company</th>
<th>Name</th>
<th>Type</th>
<th>Energy (kJ)</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow &amp; Gate</td>
<td>Rice Pudding</td>
<td>P</td>
<td>443</td>
<td>2.7</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Apple Crumble</td>
<td>P</td>
<td>434</td>
<td>3.1</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Yoghurt &amp; Orange &amp; Banana</td>
<td>P</td>
<td>441</td>
<td>3.2</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Chocolate Pudding</td>
<td>J</td>
<td>451</td>
<td>3.5</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Tropical Fruit Yoghurt</td>
<td>J</td>
<td>393</td>
<td>1.6</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Pineapple &amp; Banana Custard</td>
<td>J</td>
<td>395</td>
<td>2.1</td>
</tr>
<tr>
<td>Milupa</td>
<td>Creamed Rice Pudding</td>
<td>p</td>
<td>443</td>
<td>2.7</td>
</tr>
<tr>
<td>Milupa</td>
<td>Apple crumble</td>
<td>p</td>
<td>434</td>
<td>3.1</td>
</tr>
<tr>
<td>Brand</td>
<td>Description</td>
<td>Pack Type</td>
<td>Price (p)</td>
<td>Rating</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>Milupa</td>
<td>Semolina with Honey</td>
<td>p</td>
<td>445</td>
<td>3.4</td>
</tr>
<tr>
<td>Milupa</td>
<td>Sunshine orange</td>
<td>p</td>
<td>446</td>
<td>3.1</td>
</tr>
<tr>
<td>Farleys</td>
<td>Rice Pudding &amp; Raspberry</td>
<td>P</td>
<td>432</td>
<td>3.6</td>
</tr>
<tr>
<td>Farleys</td>
<td>Fruit &amp; Yoghurt</td>
<td>P</td>
<td>456</td>
<td>3.0</td>
</tr>
<tr>
<td>Farleys</td>
<td>Strawberry Yoghurt</td>
<td>P</td>
<td>439</td>
<td>3.2</td>
</tr>
<tr>
<td>Heinz</td>
<td>Rice Pudding</td>
<td>T</td>
<td>387</td>
<td>2.7</td>
</tr>
<tr>
<td>Heinz</td>
<td>Banana Custard</td>
<td>J</td>
<td>367</td>
<td>1.9</td>
</tr>
<tr>
<td>Heinz</td>
<td>Strawberry Yoghurt</td>
<td>J</td>
<td>379</td>
<td>1.6</td>
</tr>
<tr>
<td>Heinz</td>
<td>Pear &amp; Raspberry Fromage Frais</td>
<td>j</td>
<td>360</td>
<td>1.6</td>
</tr>
<tr>
<td>Boots</td>
<td>Orange &amp; Banana Yoghurt</td>
<td>J</td>
<td>350</td>
<td>2.4</td>
</tr>
<tr>
<td>Boots</td>
<td>Strawberry Yoghurt</td>
<td>j</td>
<td>346</td>
<td>2.2</td>
</tr>
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</table>

### iv. Non Meat Savoury

<table>
<thead>
<tr>
<th>Brand</th>
<th>Description</th>
<th>Pack Type</th>
<th>Price (p)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow &amp; Gate</td>
<td>Cheese &amp; Tomato Bake</td>
<td>P</td>
<td>364</td>
<td>3.2</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Highland Vegetable Cheese Bake</td>
<td>J</td>
<td>352</td>
<td>4.5</td>
</tr>
<tr>
<td>Milupa</td>
<td>Cauliflower Cheese Special</td>
<td>P</td>
<td>444</td>
<td>3.0</td>
</tr>
<tr>
<td>Milupa</td>
<td>Cheese &amp; Apple Treat</td>
<td>P</td>
<td>445</td>
<td>2.9</td>
</tr>
<tr>
<td>Milupa</td>
<td>Macaroni Cheese</td>
<td>p</td>
<td>451</td>
<td>4.5</td>
</tr>
<tr>
<td>Heinz</td>
<td>Cheesy Parsnip &amp; Potato Bake</td>
<td>T</td>
<td>303</td>
<td>3.5</td>
</tr>
<tr>
<td>Heinz</td>
<td>Pasta Vegetable Bake</td>
<td>T</td>
<td>347</td>
<td>3.1</td>
</tr>
<tr>
<td>Farleys</td>
<td>Cheese &amp; Vegetable Bake</td>
<td>P</td>
<td>431</td>
<td>3.5</td>
</tr>
<tr>
<td>Boots</td>
<td>Cheddar Cheese &amp; Apple</td>
<td>p</td>
<td>434</td>
<td>3.0</td>
</tr>
</tbody>
</table>

### v. Meat Savoury

<table>
<thead>
<tr>
<th>Brand</th>
<th>Description</th>
<th>Pack Type</th>
<th>Price (p)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow &amp; Gate</td>
<td>Roast Turkey Dinner</td>
<td>P</td>
<td>445</td>
<td>3.4</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Roast Pork &amp; Apple</td>
<td>P</td>
<td>429</td>
<td>3.3</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Lancashire Hotpot</td>
<td>J</td>
<td>342</td>
<td>3.2</td>
</tr>
<tr>
<td>Cow &amp; Gate</td>
<td>Rosie's Orchard Chicken</td>
<td>j</td>
<td>320</td>
<td>3.1</td>
</tr>
<tr>
<td>Milupa</td>
<td>Normandy Casserole</td>
<td>P</td>
<td>429</td>
<td>3.3</td>
</tr>
<tr>
<td>Farleys</td>
<td>Hawaiian Special Chicken</td>
<td>p</td>
<td>413</td>
<td>4.4</td>
</tr>
<tr>
<td>Boots</td>
<td>Vegetable &amp; Steak Dinner</td>
<td>p</td>
<td>442</td>
<td>3.0</td>
</tr>
<tr>
<td>Boots</td>
<td>Baked Beans &amp; Ham</td>
<td>j</td>
<td>335</td>
<td>4.5</td>
</tr>
</tbody>
</table>

**Abbreviations:**

APPENDIX V

Set of Feeding Guides for the Intervention Group

PRETERM WEANING STUDY

FIRST
FEEDING GUIDE
FOR PARENTS
What is Weaning?

The gradual change from a milk only diet to milk and foods eaten by the rest of the family is called WEANING.

Your baby needs to get used to eating food from a spoon rather than just drinking milk through a teat. This is a gradual process. At first, the baby must learn to take runny, bland foods from a small spoon. The variety and consistency of the solid foods is gradually increased at a pace to suit your baby.

The introduction of solid foods is usually divided into stages.

Stage One: Only pureed foods are used. Only a limited range of foods are offered to the baby. These include some cereals, some vegetables and fruit, simple puddings and lean meats. This stage should last 3-6 months.

Stage Two: Mashed foods and then chopped foods are gradually introduced. A wider variety of foods is offered including wheat products, eggs and fish. As the baby’s teeth develop then soft finger foods such as buttered bread and toast can be given.

Stage Three: More family foods are introduced. The food should be minced or chopped for meals. Biscuits, fruit and other finger foods should be given between meals. At around one year of age, the baby can be encouraged to feed him/herself.

Milk Feeds: Your baby should continue to receive breast or a baby formula milk, as his/her main drink until he/she is at least one year old. Cow’s milk (normal, doorstep milk) should not be used as a drink before one year of age. A few weeks after weaning has begun, small amounts of cow’s milk products e.g. fromage frais, custard and yoghurt can be used in baby meals.

When to start.

1. Your baby should be around 3 months old.

2. Your baby should weigh at least 7½ lb (3.5 kg).

3. Your baby’s expected date of delivery should be past.

4. You feel your baby is ready for something new. You may sense this because he/she may seem less satisfied with baby milk alone. He/she may be more wakeful and may dribble more. His/her weight gain may not be so good.

When your baby has reached, the age and weight above, and you feel he/she is ready, then you should begin weaning.
How to begin:

1. It is very important in the first few weeks that your baby continues to take his/her full amount of breast or bottle milk. The amount of solid food the baby actually swallows will be minimal and will not provide much nourishment. At this time the baby is just getting used to a spoon and the feel and taste of something thicker than milk in his/her mouth.

2. Choose a time of day when your baby is most alert and you have a little extra time to spend on a feed.

3. Offer the solid when you think your baby will be most ready and least fussy. This may be before any milk or after some of the milk.

4. Support the baby in a semi sitting position on your lap and offer a little of the tepid prepared solid from a small teaspoon or a baby spoon.

5. Only half or quarter fill the feeding spoon to begin with. Much of the solid may come back out of your baby’s mouth until he/she gets the idea of how to swallow it. This is a normal part of baby learning! Your baby may eat one-three full teaspoons of the cereal, at each feeding.

6. All foods offered in the first few weeks should have the consistency of double cream. Slightly thicker purees can be given when the baby is used to very runny solids. Home-prepared foods can be pureed by using a food processor or a Baby Mouli. Soft, cooked foods e.g. some vegetables, can be mashed and pressed through a sieve.

7. All foods, apart from cold puddings, should be slightly warm, not hot! Stir foods and test their temperature before feeding them to your baby. This is very important if you cook by microwave.

8. All foods should be freshly prepared just before a feed. Any leftovers must be thrown away. However, it is safe to cook vegetables with or without meat in batches. The food not for immediate consumption should be quickly cooled and then frozen for future use. It may be stored for up to one month. It should be thoroughly defrosted in a refrigerator for several hours, and quickly warmed, immediately before use.

9. Don’t add any solids to a bottle. All baby foods must be given on a spoon.

10. Allow your baby to set the pace. If a food is refused, try again in a week or two. Let your baby decide how much of each meal he/she wants to eat.

11. When using ready prepared baby foods, only first stage baby foods should be offered to your baby.
**STAGE ONE**

**What foods to begin with:**

The Special Milk
All recommended cereals and home-prepared foods should be mixed with enough of the special milk, Nutriprem, to make a thin creamy mix.
The special milk called Nutriprem is a milk formula specially produced to meet the feeding needs of low birth weight babies. It is widely used in the Special Care Baby Units of hospitals, some babies are discharged from the hospital with Nutriprem as their regular milk. We believe it will make a more nutritious mixing milk for baby food than regular milk formula.
Nutriprem will be provided free of charge, in small, ready-to-use bottles. Warm the mix of food and special milk by standing the feeding dish in a jug or bowl of hot water.
Immediately, replace the top on any unused milk left in the bottle and store in a refrigerator for the rest of the day.
A new bottle of milk must be used each day.

*From Week 1 of Weaning Onwards.*

**I. FIRST CEREALS**

Suitable Foods:
- Baby rice (Boots, Farleys, Cow & Gate, Milupa, Organix)
- Farex Baby Cereal (Farley’s)
- Gluten Free Rusks or Original Rusks* (Farley’s)
- Banana Breakfast (Boots)

Baby rice mixed with baby milk is the first choice for most babies. Offer this to your baby once a day for the first week or two.
If your baby rejects baby rice, try one of the other cereals.
As your baby gets used to the spoon and learns to swallow, offer the cereal twice a day or introduce one of the other cereals at a different time of day.

Mixing Instructions:
Mix one slightly rounded teaspoonful of baby rice or farex in a small dish with enough of the ‘special milk’ (about 1-2 tablespoonfuls) to make a smooth runny mixture. When rusks are used, crush about half of one rusk with enough ‘special milk’ to make a smooth, runny mixture. Other breakfasts should be made up as directed on the packet.

Gradually increase the amount of cereal you offer to your baby.

*Contains wheat flour or gluten.* Some experts recommend that babies should not eat any food containing wheat, barley or oats, until they are six months old.
From Weeks 2-4 of Weaning Onwards

II. VEGETABLES

After a week or two, introduce one or two vegetables. Vegetables can be home prepared or you can use a ready prepared baby food. The vegetable should be offered at a different time of day to the cereal.

Potato is the easiest and most acceptable first vegetable for babies. Home-prepared vegetables should be pureed, or mashed and pushed through a sieve.

Suitable Foods:
Home prepared:
- Potato, Carrot, Cauliflower, Broccoli and Parsnip, all pureed with 'special milk'.

Ready Prepared:

**In Packets**
- Cow & Gate- Vegetable Casserole
- Cow & Gate - Summer Vegetable.
- Farley's- Mediterranean Vegetables and Rice
- Farley's- Leek and Potato Pie
- Milupa- Vegetable Hotpot
- Milupa- Cauliflower And Creamed Potato
- Boots- Cauliflower and Potato Bake
- Organix- Sweetcorn & Potato

**In Jars**
- Cow & Gate- Vegetable & Bean Pilaff
- Heinz- Creamed Potato and Broccoli
- Heinz- Creamed Potato and Broccoli
- Boots- Garden Vegetables

**In Jars**
- Heinz- Creamed Potato and Broccoli
- Boots- Garden Vegetables

Preparation Methods (home made):

i. **Pureed Potato.** Boil a small potato, without adding salt, until soft. Puree the potato and add sufficient of the special milk (about 2 tablespoonfuls) provided to make a mix with the consistency of thick cream.

ii. **Pureed Potato and Carrot.** Boil one small potato and 2 or 3 slices of carrot, without adding salt, until soft. Puree the potato and carrot, and add sufficient of the special milk (about 3 tablespoonfuls) provided to make a mix with the consistency of cream.

iii. **Pureed Potato and Cauliflower.** Prepare as for potato and carrot, using one small potato and 2 small florets of cauliflower.

iv. **Pureed Potato and Broccoli.** Prepare as for potato and carrot, using one small potato and 2 small florets of broccoli.

v. **Pureed Potato and Parsnip.** Prepare as for potato and carrot, using one small potato and 2 or 3 slices of parsnip.

Preparation Methods (ready-made):

i. **Packet Meals.** Mix as directed on the packet, using warm, previously boiled water.
ii. **Jars and Cans.** Release top of container and stand in hot water for a few minutes. Stir contents and check temperature before serving.

*From Weeks 3-8 of Weaning Onwards*

### III. PUDDINGS AND FRUIT

When your baby is happy to eat from a spoon, you can start introducing puddings with or without fruit. These can be introduced so that your baby is offered solids up to three different times during the day, or as a dessert course after the vegetables. Make sure that you offer more savoury and cereal foods to your baby than sweet foods.

**Suitable Foods:**

**Home prepared:**
- Banana Rice Pudding
- Pureed Banana and Special Milk
- Stewed Apple and Custard
- Fromage Frais and Strawberry

**Ready Prepared:**

**In Packets**
- Cow & Gate- Rice Pudding
- Cow & Gate- Yoghurt, Orange & Banana
- Cow & Gate- Apple & Banana Pudding
- Farley’s-Fruit & Yoghurt
- Farley’s- Strawberry Yoghurt
- Farley’s- Raspberry & Red Currant Fool
- Farley’s- Rice Pudding & Raspberry
- Milupa- Sunshine Orange
- Milupa- Sunripe Banana
- Milupa- Creamed Rice Pudding
- Boots- Strawberry Dream
- Boots-Banana Pudding
- Organix- Banana Apple & Orange*
- Organix- Apple & Raspberry*

**In Jars or Cans**
- Cow & Gate- Chocolate Dream
- Cow & Gate- Pineapple & Ban. Custard
- Cow & Gate- Rice Pudding
- Cow & Gate- Orange & Banana Dream
- Cow & Gate- Strawberry & Ban. Dream
- Heinz- Banana Custard
- Heinz- Pear & Raspberry Fromage Frais
- Heinz- Rice Pudding
- Heinz- Strawberry Yoghurt Dessert
- Heinz- Banana Yoghurt Dessert
- Heinz- Apple/Blackcurrant Yoghurt
- Heinz- Chocolate & Banana
- Boots- Apricot Dream
- Boots- Banana Pudding
- Boots- Rice Pudding with Cinnamon
- Organix- Banana & Cocon Pudding*
- Organix- Fruit Compote*
- Organix- Prunes & Oatmeal*

**Preparation Methods (home made):**

i. **Banana Rice Pudding.** Mash thoroughly or puree about half of a ripe banana and mix one tablespoonful of banana and ½ tablespoonful of baby rice with special milk.
ii. Pureed Banana and Special Milk. Mash thoroughly or puree about half of a ripe banana and mix with enough of the special milk (1-2 tablespoonfuls) to make a mix with the consistency of custard.

iii. Stewed Apple and Custard. Mix one tablespoonful of pureed stewed apple with two tablespoonfuls of custard made according to the manufacturer’s instructions with whole cow’s milk and sugar. For the apple either use ready prepared baby food or stew and puree a peeled and cored apple with sugar to taste and the minimum of water. Mashed banana or stewed pear could be used as an alternative to apple.

iv. Fromage Frais and Strawberry. Puree or sieve three or four strawberries from a tin of strawberries in syrup. Mix one tablespoonful of the fruit puree with one tablespoonful of fromage frais. Pureed raspberries in syrup, pureed banana or pureed stewed apple could be used as alternatives to the strawberries.

Preparation Methods (ready-made): See section II.

From Week 6 of Weaning Onwards

IV. BUTTER, CHEESE, CREAM, FROMAGE FRAIS AND YOGHURT

When your baby has accepted a range of cereals, vegetables and puddings, then unsalted butter and olive oil can be used for cooking baby’s food or mixing with it. A small amount of a grated hard cheese, such as Cheddar, can be melted with vegetable dishes to add flavour, or a small amount of cream cheese can be mixed in. Similarly, cream, fromage frais and full fat plain yoghurt can be used to improve the texture and flavour of baby food.

Please note that your baby should eat less than 15g (½oz) of cheese per day. This is because of the high salt content of cheese.

Your baby should now accept a solid feed three times a day. Usually, a cereal will be offered at breakfast time. A vegetable dish made with butter, cream, cheese or olive oil will be offered at lunchtime and a pudding for supper.

Suitable Foods:
For Use in Home Prepared Baby Foods:
- Unsalted or low salt butter
- Olive Oil
- Cheddar and cream cheese
- Cream
- Plain full fat fromage frais
- Plain full fat yoghurt

Ready Prepared:

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<th>In Packets</th>
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<tr>
<td>Cow &amp; Gate- Cheese &amp; Tomato Bake</td>
<td>Cow &amp; Gate-Vegetable &amp; Cheese Mornay</td>
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<tr>
<td>Farley’s- Cheese &amp; Vegetable Bake</td>
<td>Heinz-Cheesy Parsnip &amp; Potato Bake</td>
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Preparation Method (home made):

i. For Butter and Olive Oil. A little added butter or olive oil may be mixed with a vegetable and ‘special milk’ puree. Butter and olive oil may be used as cooking fats for meat later.

ii. For Cheese. Mix one teaspoonful of grated cheddar with hot cooked vegetable before pureeing, or add one teaspoonful of cream cheese to the pureed vegetable and mix well. See above for vegetable preparation. Then mix with special milk to obtain the consistency of double cream.

iii. Cream, Fromage Frais, Yoghurt. Up to a teaspoonful per tablespoonful of food, of any of these may be added to a pudding or vegetable dish to improve taste and flavour.

Preparation Methods (ready made): See section II.

From Weeks 6-12 of Weaning Onwards

V. MEAT WITH VEGETABLES

When your baby is able to eat from a spoon easily and is taking a good variety of foods at least twice a day, then you can begin to introduce meat to your baby’s diet. Meat is a very good source of the protein and the minerals your baby needs to grow.

Suitable Foods:
Home prepared:

Any Pureed Combination of:
Chicken, Lamb, Beef, Pork, Turkey, Chicken Liver or Lamb’s Liver, with
Potato, Rice (Baby or Adult) or Pasta* (Baby or Adult), with
A Vegetable such as Peas, Carrot, Cauliflower, Swede, Broccoli or Cabbage, and
Special Milk.

Ready Prepared:

In Packets
Cow & gate-Season Vegetables & Chicken
Cow & gate- Farmhouse Veg. with Lamb
Cow & gate-Roast Turkey Dinner
Farley’s- Beef Cottage Pie
Farley’s- Country Veg. with Turkey
Farley’s- Farmhouse Veg. & Chicken
Farley’s- Hawaiian Special Chicken

In Jars or Cans
Cow & Gate- Rosie’s Orchard Chicken
Cow & Gate- Primavera Lamb
Cow & Gate- Veg. & Pork Casserole
Cow & Gate - Peas, Carrot & Country Chicken
Boots- Baked Beans & Ham
Preparation Method (home made):

Use up to one slice (about 15g/½oz) of lean chicken, lamb, beef, pork, turkey or liver, which has been boiled, roasted or braised. Combine the meat with one boiled potato (50g/2oz) or one tablespoonful of cooked white rice or one tablespoonful of cooked white pasta*; and one tablespoonful (25g/1oz) of cooked vegetable. Puree all the ingredients together and use the special milk (5-6 tablespoonfuls) to form a creamy mixture.

All the ingredients must be cooked without any salt added to the water or cooking fat. Potato and non-fibrous vegetables (e.g. cauliflower and new carrots) may be well mashed now rather than pureed if your baby is eating from a spoon without difficulty. The excess portions of the mixture before the milk is added may be quickly frozen for up to one month in portion size containers and used later.

Preparation Methods (ready made): See section II.

* CONTAINS WHEAT FLOUR OR GLUTEN

Note:
All packet foods should be mixed as directed on the packet. If a packet food can be mixed with baby milk or boiled water, use special milk, otherwise mix the powder to the correct thickness with cooled, previously boiled water.
DRINKS

UPTO 6 MONTHS OF AGE

Baby Milk
This will be the main food and drink up to 6 months of age. Breast milk and infant milk formulas are the only suitable baby milks for this age group.

Boiled Water
Water from the tap, which has been boiled and cooled, can be used as a drink for your baby. You should offer the water after a milk or solid feed, or between feeds, if your baby seems thirsty. Offer water in hot weather, when your baby seems feverish or when he/she won’t settle.
Bottled fizzy waters and ‘natural mineral water’ are not suitable for babies. Bottled, still spring water may be used, but it should still be boiled and then cooled before use.
Purified water with a hint of fruit flavour produced especially for babies, e.g. by Boots, can be offered instead of plain, boiled water from 4 months of age.
No other liquids are suitable for preterm babies aged less than 6 months.

FROM 6 MONTHS TO 1 YEAR

Baby Milk
This will still provide a large proportion of the food and drink for a baby up to 12 months of age. Breast milk, an infant formula or a follow-on milk are the only suitable baby milks for this age group. Cow’s milk (doorstep milk) is not a suitable drink for babies under one year of age.

Boiled Water
Coolled, boiled water should be offered after a milk or solid feed or between feeds, to a baby who seems thirsty. Offer water in hot weather or when your baby seems feverish or irritable.
Bottled fizzy waters and ‘natural mineral water’ are not suitable for babies. Bottled, still spring water may be used, but it should still be boiled and cooled before use.
Purified Waters With a Hint of Flavour
Purified water with a hint of fruit flavour produced especially for babies, e.g. by Boots, can be offered instead of plain, boiled water.

Baby Fruit Drinks
These should be used only at meal times, after the milk or solid part of the meal has been given. They should preferably be given in a cup, they are acidic and contain sugar, which may cause tooth decay.
Concentrated drinks should be made up according to the manufacturer’s instructions.
Baby herbal drinks should only be used occasionally.

Pure Fruit Juices
The pure fruit juices available in various flavours for adults can be offered to babies from 8 months of age. They must be diluted, use one part of the juice diluted with 10 parts of cooled, boiled water.
These should be used only at meal times, after the milk or solid part of the meal has been given. They should be given in a cup, they are acidic and contain sugar, which may cause tooth decay.
Other Drinks
All other drinks, including squashes, soft drinks, diet drinks, fizzy drinks, flavoured milks, tea and coffee, are not suitable for babies under one year of age. They should be avoided.

EXTRA INFORMATION

Helpful Points:
Introduce as wide a range of foods as possible.
The wider the range of foods you introduce, especially meats and vegetables, the less fussy your child will be about eating.
If your child refuses a particular food, offer something he/she has already accepted, and try the new food in a week or two.
Make sure your baby eats more savoury than sweet foods.
If your baby will only accept a very small amount of food, offer milk feeds and solid foods at different times.
Once your baby is eating three meals per day and can move the food round inside his/her mouth well, try offering mashed vegetables and fruits rather than pureed foods. Meat and fibrous vegetables should still be pureed.
If your baby seems particularly hungry, offer a pudding as well as a savoury dish.
When your baby is big enough and able to sit in a high chair, feed him/her in the high chair.

FOODS TO AVOID UNTIL AT LEAST 6 MONTHS OF AGE.
Salt. A small baby’s system can’t cope with more salt than that found in foods naturally.
Honey. Very occasionally honey can contain spores which can cause very serious disease in small babies. It should not be given to babies under one year old.
Nuts and Nut products. Nuts should not be given to babies before 5 years of age. Nut products e.g. nut spreads should be avoided until 1 year.
Foods more likely to upset a baby’s system or cause an allergic reaction before 6 months of age. These are:
- Eggs
- Citrus fruits
- Fish
- Cow’s milk
- Wheat based foods which contain gluten

Readiness for the Next Stage:
Your baby should be at least seven months old.
Your baby should be eating three or more different solid foods a day.
Your baby should be able to sit in a high chair.
Your baby should be able to eat mashed vegetables.
Your baby should be eating several different types of meat, vegetable and pudding.
If you have any queries about the information in this booklet, or you are ready for your copy of Feeding Guidelines II please contact:
Lynne Marriott, School of Biological Sciences, University of Surrey
Guildford GU2 5XH. Telephone 01962 620975
PRETERM WEANING STUDY

SECOND
FEEDING GUIDE
FOR PARENTS
THE SECOND STAGE OF WEANING

Stage Two of Weaning

In stage two of weaning, it is time to gradually widen your baby’s eating experiences. He/she will already have been introduced to and accepted a range of pureed foods, such as cereals, vegetables and meats. He/she will now be coping well with eating from a spoon. In this stage of weaning, mashed foods and then chopped foods are gradually introduced. A wider variety of foods is offered including wheat products, eggs and fish. As the baby’s teeth begin to develop then soft finger foods, such as buttered toast and cooked carrot sticks, can be given.

When to start

1. Your baby should be at least seven to eight months old.
2. Your baby should be eating three meals of solid foods a day.
3. Your baby should be able to sit in a high chair.
4. Your baby should be able to eat finely mashed vegetables, like potato and carrot.
5. Your baby should be eating several different types of meat, vegetable and pudding.
6. You feel your baby is ready to cope with new experiences.

When your baby has reached, the age and stages above, and you feel he/she is ready, then you should begin the second stage of weaning.

Milk Feeds:

Your baby should continue to receive breast milk or a baby formula milk, as his/her main drink until he/she is at least one year old. Give this milk to your baby on waking and at bedtime, as well as at around meal times.
For bottle fed babies, at least 500ml of baby formula milk should be offered to your baby every day.
Cow’s milk (normal, doorstep milk) should not be used as a drink before one year of age.
When your baby is eight months old, you may wish to change his/her bottle milk to a follow-on milk formula, e.g. Cow & Gate Step-up, Milupa Forward or SMA Progress.
Cow’s milk products e.g. cheese, butter, fromage frais, custard and baby yoghurts can be used as part of your baby’s meals.

Please note: Breast milk, baby formula milk and follow-on formula milk are all called ‘baby milk’ in this booklet.
How to Begin

Remember you or a responsible adult should stay close to your baby during feeding to provide encouragement and to make sure your baby does not choke.

1. Continue to offer at least one meat meal every day.

2. Introduce foods mashed with a fork first.
   For example:
   - Potato mashed with butter and other mashed vegetables, like carrot or broccoli,
   - Mashed banana with custard.

3. After a week or two, introduce cooked foods with soft lumps.
   For example:
   - Finely chopped carrot, cauliflower, broccoli or cabbage in meals with pureed meat and mashed potato, rice or chopped pasta,
   - Chopped, stewed apple or pear with full fat fromage frais,
   - Finely chopped cauliflower with melted cheese,
   - Ready-prepared savoury meals, without meat, from the list on page 4.

4. Continue to puree home prepared meats until your baby can cope with soft lumpy foods. Continue to use ready-made meat meals from Feeding Guide 1.

5. New types of food can be gradually introduced, allow a few days between each new type of food.
   For example:
   - Wheat products, like pasta and regular rusks,
   - Fish, which must be boneless, can be offered in pureed form initially,
   - Eggs, either boiled, scrambled or finely chopped hard boiled.

6. When your baby is coping well with lumpy foods, introduce soft finger foods.
   For example:
   - A finger of buttered toast,
   - Cooked carrot sticks,
   - Grated cheese.

7. After a month or two, your baby should be able to manage finely, minced meats. Try a softer meat such as chicken or liver first. Gradually offer all meat in minced form.
   For example:
   - Finely minced chicken with mashed potato and chopped carrot,
   - Finely minced lamb's liver with mashed potato and chopped cabbage,
   - Finely minced lamb or beef with chopped, pasta and chopped, tinned tomato.
   - Ready-prepared savoury meals, with meat or fish, see list on page 4.

8. Gradually introduce a wider range of finger foods.
   For example:
   - A finger of buttered bread,
   - Half of a rusk,
   - Slices of ripe, peeled fruits, such as peach, banana, or apple,
   - Fingers of a hard cheese, like cheddar.
Ready-Prepared Baby Foods for Use in Stage 2

**BREAKFASTS:**

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**In Packets**

- **Farley's**
  - Gluten Free Rusks
  - All Other Rusks*
  - Farex

- **Cow & Gate**
  - Sunshine Banana Cereal

- **Organix**
  - Banana, Orange & Yoghurt
  - Banana, Apple & Orange
  - Banana Porridge*

- **Weetabix**

- **Ready Brek**

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**In Packets**

- **Cow & Gate**
  - Creamed Porridge*
  - Harvest Cereals*
  - Yoghurt with Orange & Banana
  - Fruit Surprise*

- **Farley's**
  - Peachy Porridge*
  - Fruity Muesli*
  - Pear & Apple Oat cereal*

- **Heinz**
  - Creamed Porridge*
  - Apple & Banana Cereal*

- **Milupa**
  - Creamed Porridge Oats*
  - 7 Cereals*
  - Oat Cereal with Apple*

- **Boots, 1st Harvest**
  - Swiss Muesli with Dates, Apples & Bananas*
  - Apple & Pear*
  - Pineapple & Raspberry

- **Boots, Mothers Recipe**

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**In Jars or Cans.**

- **Cow & Gate**
- **Cow & Gate, Organic**
  - Creamed Oat Porridge*
  - Creamy Oatmeal Porridge*
SAVOURY MEALS FOR LUNCH OR TEA:

All savoury meals listed in Feeding Guide 1.

WITHOUT MEAT OR FISH:

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<th>In Packets</th>
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<tr>
<td><strong>Cow &amp; gate-</strong></td>
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<td>Winter Vegetables &amp; Cheese</td>
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<td>Cheese &amp; Tomato Pasta*</td>
<td>Cauliflower Gratin</td>
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<td><strong>Heinz-</strong></td>
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<tr>
<td>Cheesy Vegetable Pasta*</td>
<td>Cheesy Pasta &amp; Vegetables*</td>
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<td>Cheesy Pasta &amp; Vegetables*</td>
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<td>Vegetable, Tomato &amp; Pasta Bake*</td>
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<td><strong>Boots-</strong></td>
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<td><strong>Organix-</strong></td>
<td><strong>Boots, International-</strong></td>
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SAVOURY MEALS FOR LUNCH OR TEA:

WITH MEAT:

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<td>Pasta Italienne with Pork*</td>
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<td>Farmhouse Vegetable with Lamb</td>
<td>Sunday Lunch</td>
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<tr>
<td>Spagetti Bolognese*</td>
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<tr>
<td>Chicken &amp; Mushroom Supreme</td>
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<td>Garden Vegetable &amp; Chicken</td>
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<td>Vegetable &amp; Turkey Casserole*</td>
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<td>Pasta with Chicken &amp; Mushroom*</td>
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<td>Tomato &amp; Steak Hotpot</td>
<td>Pasta with Tender Lamb &amp; Vegetable*</td>
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<tr>
<td>Pasta Bolognese*</td>
<td>Pasta with Pork, Peppers &amp; Cheese *</td>
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In Packets

Boots-
Traditional Beef Dinner
Vegetable & Chicken Casserole

In Jars or Cans

Boots, International Range-
Pasta Roma*
Moussaka
Turkey & Potato Lyonnaise
Lasagne*
Chicken & Tomato Neapolitan
Creamy Vegetable Chicken Korma
Chinese Stew with Pork Balls

SAVOURY MEALS FOR LUNCH OR TEA:

WITH FISH:

In Packets
Farley’s-
Vegetable & Salmon Bake

In Jars or Cans
Cow & Gate Small World-
Paella

Heinz-
Fisherman’s Pie
Pasta Tubes with Tuna & Garden Veg.*

Boots, International Range-
Paella
Potato, Salmon & Herbs à la Crème

Useful Extras:

Pasta:

In Packets

Boots, Mother’s Recipe-
Pasta*

Organix-
Pasta Stars*

Sauce Mixes:

Gravy and cheese sauce mixes, which are made especially for babies, can be used to moisten and add flavour to savoury dishes. Do not use baby milk and a sauce like gravy, cheese, or tomato and cheese sauce. Make up and use the gravy or cheese sauce mix as directed on the packet or jar. These can be used once your baby is 9 months of age or older.

In Packets
Milupa-
Gravy
Cheese Sauce

In Jars
Organix-
Tomato & Cheese Sauce
PUDDINGS FOR LUNCH OR TEA:

All puddings listed in Feeding Guide 1.

In Packets

Cow & Gate-
- Apple Crumble*

Farley's-
- Banana Fool
- Apricot & Apple Crumble*
- Pear & Blackberry Dessert

Boots-
- Tropical Fruit Salad
- Chocolate Delight
- Banana & Orange Surprise

In Jars or Cans

Cow & Gate-
- Traditional Egg Custard*
- Traditional Rice Pudding
- Pineapple & Banana Custard*
- Banana & Apple Custard*
- Orange & Banana Dream*
- Strawberry & Banana Dream*
- Chocolate Dream
- Rice Pudding

Cow & Gate, Organic-
- Rice Pudding with Nutmeg & Vanilla

Heinz-
- Egg Custard with Apple
- Egg Custard with Rice
- Crème Caramel*
- Chocolate Pudding
- Fromage Frais, Banana & Blackcurrant

Boots-
- Egg Custard
- Egg Custard with Apple
- Crème Caramel
- Rice Pudding with Nutmeg

Boots, First Harvest-
- Creamy Pear Pudding*
- Dairy Rice Dessert and Maple Syrup*

Boots, Mother's Recipe-
- Banana Dessert

* These foods contain wheat flour or gluten.
Once your baby has accepted a food containing wheat flour e.g. pasta, regular rusks or bread, all the foods with an asterix (*) next to the name can be used.

All packet foods should be made up as directed on the packet. If a particular packet food can be mixed with baby milk or boiled water, use 'special milk' or follow-on milk, otherwise mix to the correct thickness with boiled water.
How to Prepare Foods

Milk for Mixing
- **Special milk (Nutriprem):**
  Cereals, which can be mixed with milk (see Breakfasts), and home-prepared foods should be mixed with enough of the special milk, to make a thick creamy mix. Warm the mix of food and special milk by standing the feeding dish in a jug or bowl of hot water. Immediately, replace the top on any unused milk left in the bottle and store in a refrigerator for the rest of the day. A new bottle of milk must be used each day.

- **Follow-on milk:**
  When your baby is eight months old, you can start to use a follow-on milk for mixing with breakfast cereals and home-prepared foods, rather than the 'special milk'. Cow & Gate Step-up, Milupa Forward and SMA Progress are all follow-on milks.

Preparation
- All home-prepared foods should be cooked without the addition of salt.

- Regular gravies and adult, ready-made, savoury sauces contain too much salt for young babies and should not be used. Milupa gravy and cheese sauce can be used.

- All foods offered in the first week or two should have the consistency of mashed potato. Home-prepared foods can be pureed by using a food processor, sieve, or a Baby Mouli. Cooked vegetables and bananas can be mashed. As your baby progresses, foods can be minced or finely chopped. When your baby is ready for minced foods, these can be prepared with a hand mincer or the mincing blade of a food processor.

- All foods, apart from cold puddings, should be warm, not hot! Stir foods and test their temperature before feeding them to your baby. It is especially important to stir food thoroughly, if you cook by microwave.

- All foods should be freshly prepared just before a feed. Any leftovers must be thrown away. However, it is safe to cook vegetables with or without meat in batches. The food not for immediate consumption should be quickly cooled and then frozen for future use. It may be stored for up to one month. It should be thoroughly defrosted in a refrigerator for several hours, and quickly warmed, immediately before use.

- Don’t add any solids to a bottle. All food must be given on a spoon or as a finger food.

- When using shop bought, ready prepared baby foods, first stage and second stage baby foods can be offered to your baby. First stage baby foods will say “Recommended for babies from 4 months old” on the jar, tin or packet, second stage baby foods will say “Recommended for babies from 7 months old” on the jar, tin or packet.

Timing
- Allow your baby to set the pace. If a food is refused, try again in a week or two. Let your baby decide how much of each meal he/she wants to eat.

- Finger foods can be given as part of a meal, e.g. a toast soldier as part of breakfast, or as a snack between meals, e.g. half a rusk at mid morning.
Suggested Daily Menus at the Start of the Second Stage

Breakfast:
- Rusk made with special milk or follow-on milk,
- Sunshine banana cereal made with special milk or follow-on milk,
- Baby porridge made with boiled water.

Lunch:

Main Course
- Mashed potato, finely chopped, well cooked broccoli and pureed chicken, mixed with special milk or follow-on milk,
- Baby rice, finely chopped, well cooked carrot and pureed lamb, mixed with special milk or follow-on milk,
- Any second stage baby main meal from the recommended list.

Pudding
- Mashed banana and custard,
- Finely chopped tinned strawberries and fromage frais,
- Any first or second stage baby pudding from the recommended list.

Tea or Supper:

Main Course
- Mashed, well cooked cauliflower, mashed potato & melted cheese,
- Well cooked rice with finely chopped tinned tomatoes and melted cheese,
- Any first or second stage baby savoury meal from the recommended list.

Pudding
- If required, as for lunch.

Snacks:
These may be given as part of the meal or as a snack between meals.
- A finger of buttered toast,
- Cooked carrot sticks,
- Grated cheese,
- Baby yoghurt from the recommended list.

Milk:
- Offer breast or formula milk with meals, on waking and before bedtime.
Suggested Daily Menus for Later in the Second Stage

Breakfast;
Rusk made with follow-on milk, and buttered toast fingers,
or
Baby porridge made with boiled water, and eggy bread and butter fingers,
or
Weetabix made with follow-on milk, and banana slices or yoghurt.

Lunch:
Main Course
Shepherd’s pie (minced lamb, potato, Milupa gravy) with chopped cabbage,
or
Boiled rice, chopped carrot and minced chicken in a follow-on milk sauce,
or
Chopped pasta, minced beef, chopped broccoli with tinned, chopped tomatoes,
or
Any second stage baby main meal from the recommended list.
Pudding
Chopped banana and custard,
or
Rice pudding,
or
Chopped ripe peach and fromage frais,
or
Any first or second stage baby pudding from the recommended list.

Tea or Supper:
Main Course
A boiled egg and toast soldiers,
or
Mashed boiled white fish/chopped fish finger with chopped, tinned tomato,
or
Scrambled egg and chopped spaghetti and chopped tomato,
or
Chopped, cooked cauliflower with mashed pasta and Milupa cheese sauce,
or
Any first or second stage baby savoury meal from the recommended list.
Pudding
If required, as for lunch.

Snacks:
These may be given as part of the meal or as a snack between meals.
Fingers of buttered toast, bread and butter soldiers and rusks,
Fingers of hard cheese, cooked carrot sticks and slices of peeled fruit,
Baby yoghurts from the recommended list.

Milk:
Offer breast or formula milk with meals, on waking and before bedtime.
DRINKS

FROM 6 MONTHS TO 1 YEAR

Baby Milk
This will still provide a large proportion of the food and drink for a baby up to 12 months of age. Breast milk, an infant formula or a follow-on milk are the only suitable baby milks for this age group.

Cow’s milk (doorstep milk) is not a suitable drink for babies under one year of age.

Boiled Water
Cooled, boiled water should be offered after a milk or solid feed or between feeds, to a baby who seems thirsty. Offer water in hot weather or when your baby seems feverish or irritable.

Bottled fizzy waters and ‘natural mineral water’ are not suitable for babies.

Bottled, still spring water may be used, but it should still be boiled and cooled before use.

Purified Waters With a Hint of Flavour
Purified water with a hint of fruit flavour produced especially for babies, e.g. by Boots and Heinz, can be offered instead of plain, boiled water.

Baby Fruit Drinks
These should be used only at meal times, after the milk or solid part of the meal has been given. They should preferably be given in a cup, they are acidic and contain sugar, which may cause tooth decay.

Concentrated drinks should be made up according to the manufacturer’s instructions.

Baby herbal drinks should only be used occasionally.

Pure Fruit Juices
The pure fruit juices available in various flavours for adults can be offered to babies from 8 months of age. They must be diluted, use one part of the juice diluted with 10 parts of cooled, boiled water.

These should be used only at meal times, after the milk or solid part of the meal has been given. They should be given in a cup, they are acidic and contain sugar, which may cause tooth decay.

Other Drinks
All other drinks, including squashes, soft drinks, diet drinks, fizzy drinks, flavoured milks, tea and coffee, are not suitable for babies under one year of age. They should be avoided.
**EXTRA INFORMATION**

**Helpful Points:**

Introduce as wide a range of foods as possible.
The wider the range of foods you introduce, especially meats and vegetables, the less fussy your child will be about eating.
If your child refuses a particular food, offer something he/she has already accepted, and try the new food in a week or two.
Make sure your baby eats more savoury than sweet foods.
If your baby will only accept a very small amount of food, offer milk feeds and solid foods at different times.
If your baby seems particularly hungry, offer a pudding as well as a savoury dish.
When your baby is able to hold a spoon, let him/her have a spoon for part of meal times.
Guide his/her hand and let him/her start to feed him/herself. This will be very messy!

**Foods to avoid until at least one year of age.**

Salt. A small baby’s system can’t cope with more salt than that found in foods naturally.
Honey. Very occasionally honey can contain spores which can cause very serious disease in small babies. It should not be given to babies under one year old.
Nuts and Nut products. Nuts should not be given to babies before 5 years of age. Nut products, such as nut spreads and peanut butter should be avoided until 1 year.
Foods more likely to upset a baby’s system or cause an allergic reaction are:
  - Eggs
  - Citrus fruits
  - Fish
  - Cow’s milk
  - Wheat based foods which contain gluten

Introduce these foods one at a time and check they do not cause any adverse reaction. Do not give a particular food again if you think your baby reacted badly to it, until you have consulted your doctor or your health visitor. Cow’s milk should only be used in cooking, not as a drink.

**Readiness for the Next Stage:**

Your baby should be at least 10-11 months old.
Your baby should be able to feed him/herself finger foods in a high chair.
Your baby should be able to eat minced meat and small lumps of other foods.
Your baby should be able to put a spoon with food on it into his/her mouth.
Your baby enjoys eating, at times, with the rest of the family.

If you have any queries about the information in this booklet, or you are ready for your copy of Feeding Guidelines III please contact:
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PRETERM WEANING STUDY

THIRD FEEDING GUIDE FOR PARENTS
THE THIRD STAGE OF WEANING

STAGE THREE OF WEANING

In stage three of weaning, it is time to extend your baby’s eating experiences, so that he/she can eat the same foods as the rest of the family. He/she will already have been introduced to and accepted quite a wide range of different foods. He/she will now be coping well with eating minced food and finger foods.

In this stage of weaning, you can start to give your baby most of the foods you eat yourself. To begin with all foods should be minced or given as finger sized pieces. Special care should be taken to remove any bones, hard lumps or pieces of food, which are difficult to chew. Gradually you can introduce chopped food instead of minced food.

WHEN TO START

7. Your baby should be at least 10-15 months old.
8. Your baby should be eating a variety of minced foods, including minced meat or minced pulses.
9. Your baby should be able to eat a variety of finger foods.
10. Your baby should be able to begin to feed himself/herself with a spoon.
11. You feel your baby is ready to cope with new experiences.

When your baby has reached, the age and stages above and you feel he/she is ready, then you should begin the third stage of weaning.

MILK FEEDS:

Your baby should continue to receive breast milk or a baby formula milk, as his/her main drink until he/she is one year past the date when he/she was expected to be born. Give this milk to your baby as his/her main drink several times a day. For bottle fed babies, about 500 ml (1 pint) of baby formula milk should be offered to your baby every day. This can be reduced to about 350ml (2 pint) after one year of age.

Cow’s milk (normal, doorstep milk) should not be used as a drink until one year past your baby’s expected date of delivery. Cow’s milk can be used in cooking before your baby is one year old. Cow’s milk can be used for mixing with dry foods, such as breakfast cereals, from when your baby is one year old.

For babies and toddlers, use whole (full cream) cow’s milk not semi skimmed or skimmed milk.

Please note: Breast milk, baby formula milk and follow-on baby formula milk are all called ‘baby milk’ in this booklet.
HOW TO BEGIN

Remember you or a responsible adult should stay close to your baby during feeding to provide encouragement and to make sure your baby does not choke.

1. Continue to offer your baby at least one meal, which contains meat or fish every day.

2. Introduce a small portion of family food, with all parts minced or chopped into small pieces.
   For example:
   - Potato, vegetables and chicken casserole,
   - Sausages (low salt) and baked beans (low salt)
   - Fruit pie with custard.

3. New types of meals can be gradually introduced. Let your baby share more regular family meals and mealtimes as he/she progresses with different kinds of meals.

4. Gradually offer different sorts of family dishes to your baby.
   For example:
   - Roast meals, casseroles, pasta dishes, pies and baked tarts.

5. Start chopping the softer parts of each meal. When your baby is used to lots of soft chopped food, give meat and raw vegetables in small chopped pieces.

6. Encourage your baby to feed himself/herself with a spoon.

7. Gradually introduce a wider range of finger foods.
   For example:
   - Raw vegetable sticks,
   - Fresh fruit slices,
   - Sandwich fingers,
   - Small slices of soft pizza,
   - Squares of melted cheese on toast,
   - Plain biscuits,
   - Plain or cheese crackers,
   - A slice of cake (nut free).
HOW TO PREPARE FOODS

Milk for Mixing

- **Baby Milk:**
  Cereals, which can be mixed with milk, should be mixed with your baby’s regular milk until your baby is one year old. Cow & Gate Step-up, Milupa Forward and SMA Progress are all follow-on milks which are produced for older babies. These can be used as your baby’s regular milk, if he/she is not breast fed, and can also be used for mixing with other foods.

- **Cow’s Milk:**
  When your baby is 12 months old, you can start to use regular, whole cow’s milk for mixing with breakfast cereals and home-prepared foods, rather than baby milk. All babies and toddlers should be given ‘whole milk’ not semi skimmed or skimmed milk.

Preparation

- **All foods,** apart from cold puddings, **should be warm, but not hot!** Stir foods and test their temperature before feeding them to your baby. It is especially important to stir food thoroughly if you heat it in a microwave.

- **All foods should be freshly prepared just before a meal. Any leftovers must be thrown away.** However, it is safe to cook meals in batches. The food not for immediate consumption should be quickly cooled and then frozen for future use. When you are ready to use it, it should be thoroughly defrosted in a refrigerator for several hours and thoroughly warmed, immediately before serving.

- **When using shop bought, ready prepared baby foods,** ‘Second Stage’ baby foods can be offered to your baby. Second stage baby foods will say “Recommended for babies from 7 months old” on the jar, tin or packet.

- **When your baby is at least one year of age ‘Toddler Stage’ baby foods can be used.** These will say “Recommended for babies from one year old” on the jar, tin or packet. See the list of recommended foods on page 6 of this guide.

- **Full fat** varieties of yoghurt, fromage frais and milk should be used in meal preparation.

- **Low salt** varieties of baked beans, sausages and pre-cooked spaghetti should ideally be used in meal preparation.

- **All home-prepared foods should be cooked without the addition of salt.**

- **Regular gravies and adult, ready-made, savoury sauces contain a lot of salt and so only small amounts of these should be used in your baby’s meals.**

- **Finger foods** can be given as part of a meal, e.g. toast soldiers as part of breakfast or as a snack between meals e.g. half a rusk at mid morning.
Suggested Daily Menus for the Start of the Third Stage

Breakfast;
Rusk with follow-on milk and buttered toast fingers,
or
Boiled egg with bread and butter soldiers,
or
Weetabix with follow-on milk and banana slices.

Lunch:
Main Course
Mashed potato, chopped, cooked carrots, minced chicken and gravy,
or
Chopped pasta with bolognese sauce,
or
Chopped roast potatoes, chopped cauliflower in cheese sauce and minced lamb.
Pudding
Stewed fruit (chopped) and custard,
or
Rice pudding.

Tea or Supper:
Main Course
Cheese on toast squares with chopped tomato,
or
Chopped fish finger with baked beans,
or
Scrambled egg with tinned spaghetti.
Pudding
Fresh fruit slices and yoghurt.

Second stage breakfasts, savoury meals and puddings from the recommended list in the Second Feeding Guide can also be used.

Snacks:
These may be given as part of the meal or as a snack between meals.
Fingers of buttered bread or toast,
Raw vegetable sticks,
Slices of fruit,
A plain cracker or a biscuit,
Baby fruit drink, water or diluted fruit juice.

Drinks:
Offer breast or formula milk with meals or on waking and before bedtime. Water, a baby fruit drink or diluted fruit juice may be offered with one or two meals.
Suggested Daily Menus for Later in the Third Stage

Breakfast;

Weetabix mixed with cow’s milk, and buttered toast fingers,

or

Porridge made with cow’s milk,

or

Rice Krispies or Shreddies mixed with cow’s milk,

or

Egg, small pieces of grilled, lean bacon, grilled tomato and bread fingers.

Lunch:

Main Course

Lancashire Hotpot (chopped lamb, potato slices, chopped onion and gravy)

with chopped cabbage,

or

Boiled rice, peas and chopped chicken in a tomato or tangy sauce,

or

Chopped, roast beef, chopped broccoli with mashed potatoes and gravy.

Pudding

Small pieces of apple pie and custard,

or

Jelly and ice cream,

or

Sliced peach and fromage frais,

or

Fresh fruit.

Tea or Supper:

Main Course

Sandwich squares made with e.g. cheese, tuna or banana,

or

Small slices of soft pizza and slices of fresh tomato,

or

Scrambled egg with baked beans and toast fingers,

or

Vegetable soup with a soft bread roll.

Pudding

Apple or orange slices and/or fruit yoghurt.

Toddler stage meals and puddings from the recommended list (page 6) can also be used.

Snacks:

These may be given as part of a meal or as a snack between meals. See page 4.

Milk:

Offer baby milk, cow’s milk, water or diluted fruit juice with meals, or as required.
TODDLER STAGE BABY FOODS

These meals are suitable for toddlers aged between one and two years.

Cow & Gate Olivarit Toddler Meals-
- Spaghetti Bolognese
- Vegetable & Salmon Gratin
- Pasta Neapolitan

- Summer Orchard Crumble
- Apple Pie & Banana Custard

Cow & Gate Toddler Meals-
- Pasta Bolognese
- Vegetable & Turkey Casserole

Heinz Junior Cuisine-
- Country Vegetables & Chicken
- Pasta in a Creamy Bacon & Cheese Sauce
- Sunday Lunch, Garden Vegetables & Lamb

- Apple & Mango Crumble
- Bread & Butter Style Pudding with Juicy Sultanas

Boots Toddler Meals in Jars-
- Farmhouse Vegetables & Ham Hotpot
- Country Vegetables & Beef

Boots International Range for Toddlers-
- Raviolo
- Mexican Chicken
- Pasta & Salmon Florentine

Boots Mothers Recipe for Toddlers-
- Country Chicken with Vegetables & Rice

Baby Organix-
- Pasta ABC
- Pasta Ducks
HEALTHY EATING ADVICE FOR TODDLERS AND SMALL CHILDREN

1. Milk/Dairy Products:
Give at least 350 ml (¾ pint) of milk or 2 servings of a dairy product (cheese, yoghurt, milk pudding or fromage frais) every day.
Use whole milk and full fat dairy products.
Soft cheeses can be given after 15 months of age.

2. Starchy Foods:
Include at least one serving of bread, breakfast cereals, pastry, potato, rice or pasta with every meal.
Wholemeal bread, pasta and cereals may be introduced after 15 months of age.

3. Vegetables and Fruits
Try and include at least 4 servings of fruit/vegetable every day.
One serving for a small child is equal to 1 tablespoonful of a cooked or sliced fruit/vegetable, between ½-1 piece of larger, raw fruits, e.g. apple or orange, and 3-4 small fruits e.g. strawberries.
Including a fruit or vegetable with the main meal will improve the absorption of iron from the meal. This is very important for good health and development.

4. Meat, Fish and Meat Alternatives
Include meat, fish or a meat alternative, such as egg or pulses, in 1-2 meals every day.
Oily fish e.g. sardine, herring and mackerel are very good for growing children.
Trim the fat off the meat before serving. Use little or no added fat when cooking meat.
Small amounts of processed meats, such as liver paté, can be used after 15 months of age.

5. Meal Patterns
Encourage your child to eat three meals a day. If a snack is needed, offer fruit, yoghurt, plain crackers or lightly buttered bread. Do not let your child become dependent on salty, high fat processed foods, sweets, cakes and biscuits for a large part of his/her daily food intake. A drink of milk at bedtime is a good idea nutritionally and may encourage good sleep habits.

6. Occasional Foods
Try and keep high fat, salty foods, e.g. crisps and processed snack foods, as an occasional treat.
Similarly, foods with a lot of added sugar, e.g. sweets, cakes and chocolate bars, should be given as treats once a day or less.

7. Drinks
Milk, water, baby fruit drinks and diluted fruit juices are the most suitable liquids for toddlers. Fizzy drinks and fruit squashes both contain a lot of dissolved sugar or artificial sweeteners, such as saccharin, and are not suitable for toddlers.
Tea and coffee reduce the absorption of iron and are not suitable for toddlers.
Give fruit juice and ‘baby drinks’ in a cup rather than in a bottle to avoid tooth decay.
If you have any queries about the information in this booklet, please contact:

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APPENDIX VI

Set of Feeding Guides for the Control Group

UNIVERSITY OF SURREY

PRETERM FEEDING STUDY

FIRST
FEEDING GUIDE
FOR PARENTS
What is Weaning?

The change from a milk only diet to milk and foods eaten by the rest of the family is called WEANING.

Your baby needs to get used to eating from a spoon rather than just drinking milk through a nipple or teat. This is a gradual process. At first, the baby must learn to take runny, bland foods from a small spoon. The variety and consistency of the solid foods is gradually increased at a pace to suit your baby.

The introduction of solid foods is usually divided into three stages.

Stage One: Only pureed foods are used. Only a limited range of foods are offered to the infant. These include some cereals, some fruit and vegetables, simple puddings and lean meats. This stage should last 3-6 months.

Stage Two: Mashed foods and then chopped foods are gradually introduced. A wider variety of foods is offered including wheat products, eggs and fish. As the baby’s teeth develop then soft finger foods such as buttered bread and toast can be given.

Stage Three: More family foods are introduced. The food should be minced or chopped for meals. Biscuits, fruit and other finger foods should be offered between meals. At around one year of age, the baby can be encouraged to feed him/herself.

Milk Feeds: Your baby should continue to receive breast or a baby formula milk, as his/her main drink until he/she is at least one year old. Cow’s milk (normal, doorstep milk) should not be used as a drink before one year of age. A few weeks after weaning has been begun, small amounts of cow’s milk products e.g. yoghurt, custard and fromage frais can be used in baby meals.

When to start.

1. Your baby should be at least 4 months old.
2. Your baby should weigh at least 11 lb (5kg).
3. Your baby should be able to take food from a spoon.
4. You feel your baby is ready for something new. You may sense this because he/she may seem less satisfied with baby milk alone. He/she may be more wakeful and may dribble more. His/her weight gain may not be so good.

When your baby has reached the age and weight above, and you feel he/she is ready, then you should begin weaning.
How to begin:

1. It is very important in the first few weeks that your baby continues to take his/her full amount of baby milk. The amount of solid food the baby actually swallows will be minimal and will not provide much nourishment. At this time the baby is just getting used to a spoon and the feel and taste of something thicker than milk in his/her mouth.

2. Choose a time of day when your baby is most alert and you have a little extra time to spend on a feed.

3. Offer the solid when you think your baby will be most ready and least fussy. This may be before any milk or after some or all of the milk.

4. Support the baby in a semi sitting position and offer a little of the tepid prepared solid from a small teaspoon or a baby spoon.

5. Only half or quarter fill the feeding spoon to begin with. Much of the solid may come back out of your baby's mouth until he/she gets the idea of how to swallow it. This is a normal part of baby learning! Your baby may eat up to about one to three full teaspoons of the mixture in total, at each feeding.

6. All foods offered in the first few weeks should have the consistency of double cream. Slightly thicker purees can be given when the baby is used to very runny solids. Home prepared foods can be pureed by using a food processor or a Baby Mouli. Soft cooked foods e.g. some fruits and vegetables can be mashed and then pressed through a sieve.

7. All foods, apart from cold puddings, should be slightly warm, not hot! Stir foods and test their temperature before feeding them to your baby. This is very important if you cook by microwave.

8. All foods should be freshly prepared just before a feed. Any leftovers must be thrown away. It is safe to cook vegetables with or without meat in batches. The food not for immediate consumption should be quickly cooled and then frozen for future use. It should be thoroughly defrosted in a refrigerator for several hours, and then quickly warmed for immediate use.

9. Don't add any solids to a bottle. All baby foods must be given on a spoon.

10. Allow your baby to set the pace. If a food is refused, try again in a week or two. Let your baby decide how much of each meal he/she wants to eat.

11. Only ready prepared foods suitable for babies from four months old, i.e. first stage baby foods, should be used in this stage of weaning.
STAGE ONE

What foods to begin with:

From Week 1 of Weaning Onwards.

I. FIRST CEREALS

Suitable Foods:
- Baby rice (Boots, Farleys, Cow & Gate, Milupa)
- Farex Baby Cereal (Farley’s)
- Ready prepared Baby Breakfast foods, suitable for babies from 4 months
- Gluten Free Rusks or Original Rusks* (Farley’s)

Baby rice is the first choice for most babies. Offer this to your baby once a day for the first week or two.
If your baby rejects baby rice, try one of the other cereals.
As your baby gets used to the spoon and learns to swallow, offer the cereal twice a day or introduce one of the other cereals at a different time of day.

Mixing Instructions:
Mix 1 slightly rounded teaspoonful of baby rice or farex in a small dish with enough of your baby’s usual milk (about 1-2 tablespoonfuls) to make a smooth runny mixture.
Baby breakfasts should be prepared as directed on the container.
When rusks are used, crush about half of one rusk with enough milk to make a smooth, runny mixture.

*Contains wheat flour or gluten. Some experts recommend that babies should not eat any food containing wheat or wheat products until they are six months old.

From Weeks 2-4 of Weaning Onwards

II. FRUIT AND VEGETABLES

After a week or two, introduce one or two cooked, pureed fruits. When your baby has accepted at least one type of fruit, then introduce one or two vegetables. Fruit and vegetables can be home prepared or a ready prepared baby food. The fruit or vegetable should be offered at a different time of day to the rice.
Apple and banana are the easiest and most acceptable first fruits for babies. Potatoes, followed by carrots and cauliflower are the easiest and most acceptable first vegetables for babies.

Suitable Foods:
Home prepared:
- Pureed apple, banana and pear all mixed with baby milk.
- Pureed Potato, Carrot, Cauliflower, Swede and Parsnip, with/without baby milk.
Please note that apples and pears have low nutrient densities and should be used occasionally, rather than frequently.

**Ready Prepared:**

<table>
<thead>
<tr>
<th><strong>In Jars or Cans</strong></th>
<th><strong>In Packets</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cow &amp; Gate</strong>-</td>
<td><strong>Cow &amp; Gate</strong>-</td>
</tr>
<tr>
<td>Apricot &amp; Apple Surprise</td>
<td>Summer Fruit Salad</td>
</tr>
<tr>
<td>Vegetable &amp; Bean Pilaff</td>
<td>Vegetable Casserole</td>
</tr>
<tr>
<td></td>
<td>Summer Vegetables</td>
</tr>
<tr>
<td><strong>Cow &amp; Gate, Organic Choice Range-</strong></td>
<td></td>
</tr>
<tr>
<td>Banana &amp; Apricot</td>
<td></td>
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<tr>
<td>Apple &amp; Banana</td>
<td></td>
</tr>
<tr>
<td><strong>Heinz-</strong></td>
<td><strong>Farley’s-</strong></td>
</tr>
<tr>
<td>Apple &amp; Banana</td>
<td>Orchard Fruit Salad</td>
</tr>
<tr>
<td>Apple &amp; Mandarin</td>
<td>Leek &amp; Potato Pie</td>
</tr>
<tr>
<td>Summer Fruit</td>
<td>Mediterranean Vegetable/Rice</td>
</tr>
<tr>
<td>Creamed Potato/Broccoli</td>
<td></td>
</tr>
<tr>
<td>Farmhouse Vegetable Special</td>
<td></td>
</tr>
<tr>
<td>Creamed Vegetable Harvest</td>
<td>Milupa-</td>
</tr>
<tr>
<td><strong>Boots-</strong></td>
<td><strong>Boots-</strong></td>
</tr>
<tr>
<td>Apple &amp; Banana Puree</td>
<td>Cauliflower &amp; Potato Bake</td>
</tr>
<tr>
<td>Mixed Fruit Puree</td>
<td></td>
</tr>
<tr>
<td>Apple Banana &amp; Strawberry</td>
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<tr>
<td>Garden Vegetables</td>
<td></td>
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<tr>
<td><strong>Boots International-</strong></td>
<td><strong>Boots Organic (Mothers Recipe)-</strong></td>
</tr>
<tr>
<td>Vegetable Ratatouille</td>
<td>Spring Carrot &amp; Rice</td>
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<tr>
<td></td>
<td>Potato &amp; Spring Carrot</td>
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<tr>
<td><strong>Boots Organic (Mothers Recipe)-</strong></td>
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<tr>
<td>Garden Vegetables with Wholegrain Rice</td>
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<tr>
<td>Apple &amp; Blueberry Treat</td>
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<tr>
<td><strong>Organix-</strong></td>
<td><strong>Organix-</strong></td>
</tr>
<tr>
<td>Fruit Compote *</td>
<td>Banana Apple &amp; Orange*</td>
</tr>
<tr>
<td>Organic Lambada Peas</td>
<td></td>
</tr>
</tbody>
</table>

**Preparation Methods (home made):**

i. **Pureed Stewed Apple.** Stew and puree a peeled and cored apple with sugar to taste and the minimum of water. Baby milk should be added to make a mix with the consistency of custard. Stewed pear could be used as an alternative to apple.

ii. **Pureed Banana** Mash thoroughly or puree about half of a ripe banana. Baby milk should be added to make a mix with the consistency of custard.

iii. **Pureed Potato.** Boil a potato, without adding salt, until soft. Puree the potato and add sufficient baby milk to make a mix with the consistency of thick cream.

iv. **Pureed Carrot.** Boil 4-6 slices of carrot, without adding salt, until soft. Puree the carrot, and add sufficient baby milk to make a mix with the consistency of thick cream.

v. **Pureed Mixed Vegetables.**

*eg Potato and Cauliflower.* Prepare as above using one medium potato and 2 small florets of cauliflower. *eg Potato and Swede.* Prepare as above using one medium potato and 2 cubes of swede.
Preparation Methods (ready-made):

i. **Packet Meals.** Mix as directed on the packet. If a packet food can be mixed with baby milk or cooled, previously boiled water, use baby milk.

ii. **Jars and Cans.** Release top of container and stand in hot water for a few minutes. Stir contents thoroughly and check temperature before serving.

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**III. PUDDINGS**

When your baby is happy to eat from a spoon, you can start introducing puddings with or without fruit. These can be introduced so that your baby is offered solids at three different times during the day, or as a dessert course after vegetables. Make sure that you offer more savoury and cereal foods than sweet foods to your baby.

**Suitable Foods:**

Home prepared:
- Pureed Banana and Custard
- Banana Rice Pudding
- Stewed Apple and Custard
- Yoghurt and Pear
- Fromage Frais and Strawberry

Ready Prepared:

**In Jars or Cans**

- **Cow & Gate**—All except Traditional Egg Custard
- **Heinz**—All Yoghurt Desserts, Chocolate Pudding, Rice Pudding, Summer Fruit Delight, Chocolate & Banana Pudding, All Fromage Frais desserts
- **Farley’s**—Raspberry Yoghurt, Raspberry & Red Currant Fool, Banana Custard, Rice Pudding with Raspberry

**In Packets**

- **Cow & Gate**—Rice Pudding, Apple & Banana Pudding, Summer Fruit Pudding
- **Farley’s**—Creamed Rice Pudding
- **Milupa**—Banana Pudding, Strawberry Dream, Rice Pudding with Apple, Fruit & Yoghurt*
- **Boots**—Banana Pudding, Strawberry Dream, Rice Pudding with Apple, Fruit & Yoghurt*
- **Boots Organic (Mothers Recipe)**—Banana Rice Pudding, Summer Peach Dessert
- **Organix**—Banana & Cocoa Pudding*, Banana Apple & Orange*, Fruit Compote *
Preparation Methods (home made):

i. Pureed Banana and Custard. Mash thoroughly or purée about half of a ripe banana and mix with one tablespoonful of custard made according to the manufacturers instructions with whole milk and sugar.

ii. Banana Rice Pudding. Mash thoroughly or puree about half of a ripe banana and mix one tablespoonful of banana with one tablespoonful the baby rice milk cereal. Preparation details for the cereal are in Section I.

iii. Stewed Apple and Custard. Mix one tablespoonful of pureed stewed apple with one tablespoonful of custard made according to the manufacturers instructions with whole milk and sugar. For the apple either use ready prepared baby food or stew and puree a peeled and cored apple with sugar to taste and the minimum of water. Stewed pear could be used as an alternative to apple.

iv. Yoghurt and Pear. Mix one tablespoonful of pureed, stewed pear with one tablespoonful of full fat plain yoghurt. Mashed banana or stewed apple could be used as an alternative to pear.

v. Fromage Frais and Strawberry. Puree or sieve three or four strawberries (fresh or tinned). Mix one tablespoonful of the fruit puree with one tablespoonful of fromage frais. Raspberries, mashed banana or stewed apple could be used as alternatives to the strawberries.

Preparation Methods (ready-made):

See section II, Fruit and Vegetables.

From Weeks 6-8 of Weaning Onwards

IV. BUTTER, CHEESE, CREAM, FROMAGE FraIS AND YOGHURT

When your baby has accepted a range of cereals, fruits, vegetables and puddings, then unsalted butter and olive oil can be used for cooking baby’s food or mixing with it. A small amount of a grated hard cheese, such as Cheddar, can be melted with vegetable dishes to add flavour, or a small amount of cream cheese can be mixed in. Similarly, cream, fromage frais and full fat plain yoghurt can be used to improve the texture and flavour of baby food.

Please note that your baby should eat less than 15g (½oz) of cheese per day. This is because of the high salt content of cheese.

Your baby should now accept a solid feed three times a day. Usually, a cereal will be offered at breakfast time. A vegetable dish or vegetable and cheese meal will be offered at lunchtime and a pudding or fruit dish for supper.

Suitable Foods:

For Use in Home Prepared Baby Foods:

Unsalted or low salted butter
Olive Oil
Cheddar and cream cheeses
Cream, Plain full fat fromage frais, Plain full fat yoghurt
Ready Prepared:

- **In Jars or Cans**
  - Cow & Gate- Cauliflower Cheese Special
  - Vegetable & Cheese Mornay
  - Cheese Vegetables

- **In Packets**
  - Cow & Gate- Cheese & Tomato Bake
  - Cheese & Tomato Pasta*

Heinz- Pasta Vegetable Bake*  
Farley's- Cheese & Vegetable Bake

Boots- Cheesy Parsnip & Potato Bake  
Milupa- Cheese & Apple Treat

- Boots- Cheddar Cheese & Apple Cheese & Pasta Bake*

Organix- Potato Cheese & Chive

Hipp- Spinach, Potato & Cheese

**Preparation Method:**

i. For **Butter and Olive Oil**. Vegetables may be pureed with a little added butter or olive oil. These may be used as cooking fats for meat in the next section.

ii. For **Cheese**. Mix one teaspoonful of grated cheddar with hot cooked vegetable before pureeing, or add one teaspoonful of cream cheese to the pureed vegetable and mix well. See above for vegetable preparation.

iii. **Cream, Fromage Frais, Yoghurt**. Up to one teaspoonful per tablespoonful of food, of any of these may added to a pudding or vegetable dish to improve the texture and flavour.

**Preparation Methods (ready-made):**

See section II, Fruit and Vegetables.

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**From Weeks 8-12 of Weaning Onwards**

**V. MEAT WITH VEGETABLES**

When your baby is able to eat from a spoon easily, is taking a good variety of foods, at least twice a day, then you can begin to introduce meat to your baby’s diet. Meat is a very good source of the protein and the minerals your baby needs to grow.

**Suitable Foods:**

Home prepared:

- Any Pureed Combination of:
  - Chicken, Lamb, Beef, Pork, Turkey, Chicken Liver or Lamb’s Liver
  - with
  - Potato, Adult White Rice or Pasta (Baby or Adult)*,
  - with
  - Vegetables such as Peas, Carrot, Cauliflower, Swede, Broccoli or Cabbage
  - and

-
Baby Milk.
Ready Prepared:

<table>
<thead>
<tr>
<th>In Jars or Cans</th>
<th>In Packets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cow &amp; Gate</strong>- All Meat Meals</td>
<td><strong>Cow &amp; Gate</strong>- All Meat Meals</td>
</tr>
<tr>
<td><strong>Heinz</strong>- All Meat Meals in Jars, except Lancashire Lamb Hotpot All Meat Meals in Cans, except Golden Sweetcorn, Veg. &amp; Chicken</td>
<td><strong>Farley’s</strong>- All Meat Meals</td>
</tr>
<tr>
<td><strong>Boots</strong>- Baked Beans &amp; Ham Sweetcorn &amp; Chicken</td>
<td><strong>Boots</strong>- Country Vegetables &amp; Lamb Farmhouse Chicken Casserole</td>
</tr>
<tr>
<td><strong>Boots International</strong>- Lasagne with Pork*</td>
<td><strong>Milupa</strong>- All Meat Meals</td>
</tr>
<tr>
<td><strong>Boots Organic (Mothers Recipe)</strong>- Vegetable Risotto with Steak Tender Vegetables &amp; Chicken</td>
<td></td>
</tr>
<tr>
<td><strong>Organix</strong>- Garden Vegetables &amp; Chicken Tomato &amp; Chicken Casserole</td>
<td></td>
</tr>
<tr>
<td><strong>Hipp</strong>- Vegetables with Rice &amp; Chicken Vegetables with Lamb Vegetable &amp; Beef Hotpot</td>
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</table>

**Preparation Method:**
Use half of one slice (about 10g) of lean chicken, lamb, beef, pork, turkey or liver, which has been boiled, roasted or braised. Combine the meat with one boiled potato (50g/2oz), or one tablespoonful of baby rice or one tablespoonful of cooked pasta; and one tablespoonful (50g/2oz) of cooked vegetable. Puree all the ingredients together and use baby milk to form a creamy mixture.

All the ingredients must be cooked without any salt added to the water.
Potato and non-fibrous vegetables (e.g. cauliflower and new carrots) may be well mashed now rather than pureed if your baby is eating competently from a spoon.

**Preparation Methods (ready-made):**
See section II, Fruit and Vegetables.

**Note:**
All packet foods should be mixed as directed on the packet. If a packet food can be mixed with baby milk or boiled water, use baby milk, otherwise mix the powder to the correct thickness with cooled, previously boiled water.

*CONTAINS WHEAT FLOUR OR GLUTEN.*
DRINKS

UPTO 6 MONTHS OF AGE

Baby Milk
This will be the main food and drink up to 6 months of age. Breast milk and infant milk formulas are the only suitable baby milks for this age group.

Boiled Water
Water from the tap, which has been boiled and cooled, can be used as a drink for your baby. You should offer the water after a milk or solid feed, or between feeds, if your baby seems thirsty. Offer water in hot weather, when your baby seems feverish or when he/she won’t settle.
Bottled fizzy waters and ‘natural mineral water’ are not suitable for babies. Bottled, still spring water may be used, but it should still be boiled and then cooled before use. Purified water with a hint of fruit flavour produced especially for babies, e.g. by Boots, can be offered instead of plain, boiled water from 4 months of age.
No other liquids are suitable for preterm babies aged less than 6 months.

FROM 6 MONTHS TO 1 YEAR

Baby Milk
This will still provide a large proportion of the food and drink for a baby up to 12 months of age. Breast milk, an infant formula or a follow-on milk are the only suitable baby milks for this age group. Cow’s milk (doorstep milk) is not a suitable drink for babies under one year of age.

Boiled Water
Cooled, boiled water should be offered after a milk or solid feed or between feeds, to a baby who seems thirsty. Offer water in hot weather or when your baby seems feverish or irritable.
Bottled fizzy waters and ‘natural mineral water’ are not suitable for babies. Bottled, still spring water may be used, but it should still be boiled and cooled before use.

Purified Waters With a Hint of Flavour
Purified water with a hint of fruit flavour produced especially for babies, e.g. by Boots, can be offered instead of plain, boiled water.

Baby Fruit Drinks
These should be used only at meal times, after the milk or solid part of the meal has been given. They should preferably be given in a cup, they are acidic and contain sugar, which may cause tooth decay.
Concentrated drinks should be made up according to the manufacturer’s instructions.
Baby herbal drinks should only be used occasionally.

Pure Fruit Juices
The pure fruit juices available in various flavours for adults can be offered to babies from 8 months of age. They must be diluted, use one part of the juice diluted with 10 parts of cooled, boiled water.
These should be used only at meal times, after the milk or solid part of the meal has been given. They should be given in a cup, they are acidic and contain sugar, which may cause tooth decay.
Other Drinks
All other drinks, including squashes, soft drinks, diet drinks, fizzy drinks, flavoured milks, tea and coffee, are not suitable for babies under one year of age. They should be avoided.

EXTRA INFORMATION

Helpful Points:
Introduce as wide a range of foods as possible.
The wider the range of foods you introduce, especially meats and vegetables, the less fussy your child will be about eating.
If your child refuses a particular food, offer something he/she has already accepted, and try the new food in a week or two.
Make sure your baby eats more savoury than sweet foods.
If your baby will only accept a very small amount of food, offer milk feeds and solid foods at different times.
Once your baby is eating three meals per day and can move the food round inside his/her mouth well, try offering mashed vegetables and fruits rather than pureed foods. Meat and fibrous vegetables should still be pureed.
If your baby seems particularly hungry, offer a pudding as well as a savoury dish.
When your baby is big enough and able to sit in a high chair, feed him/her in the high chair.

Foods to avoid until at least 6 months of age.
Salt. A small baby’s system can’t cope with more salt than that found in foods naturally.
Honey. Very occasionally honey can contain spores which can cause very serious disease in small babies. It should not be given to babies under one year old.
Nuts and Nut products. Nuts should not be given to babies before 5 years of age. Nut products e.g. nut spreads should be avoided until 1 year.
Foods more likely to upset a baby’s system or cause an allergic reaction before 6 months of age. These are:
• Eggs
• Citrus fruits
• Fish
• Cow’s milk
• Wheat based foods which contain gluten

Readiness for the Next Stage:
Your baby should be at least seven months old.
Your baby should be eating three or more different solid foods a day.
Your baby should be able to sit in a high chair.
Your baby should be able to eat mashed vegetables.
Your baby should be eating several different types of meat, vegetable and pudding.
If you have any queries about the information in this booklet, or you are ready for your copy of Feeding Guide 2 please contact:
Lynne Marriott
School of Biological Sciences
University of Surrey
Guildford GU2 5XH
Telephone 01962 620975
UNIVERSITY OF SURREY

PRETERM FEEDING STUDY

SECOND
FEEDING GUIDE
FOR PARENTS
Stage Two of Weaning

In stage two of weaning, it is time to gradually widen your baby's eating experiences. He/she will already have been introduced to and accepted a range of pureed foods, such as cereals, fruits, vegetables and meats. He/she will now be coping well with eating from a spoon. In this stage of weaning, mashed foods and then chopped foods are gradually introduced. A wider variety of foods is offered including wheat products, eggs and fish.

As the baby’s teeth begin to develop then soft finger foods, such as buttered toast and cooked carrot sticks, can be given.

When to start

1. Your baby should be at least seven to eight months old.
2. Your baby should be eating three meals of solid foods a day.
3. Your baby should be able to sit in a high chair.
4. Your baby should be able to eat finely mashed vegetables, like potato and carrot.
5. Your baby should be eating several different types of fruit, vegetable, meat and pudding.
6. You feel your baby is ready to cope with new experiences.

When your baby has reached, the age and stages above, and you feel he/she is ready, then you should begin the second stage of weaning.

Milk Feeds:

Your baby should continue to receive breast milk or a baby formula milk, as his/her main drink until he/she is at least one year old. Give this milk to your baby on waking and at bedtime, as well as at meal times.

Cow’s milk (normal, doorstep milk) should not be used as a drink for your baby before one year of age. Cow’s milk products e.g. cheese, butter, fromage frais, custard and baby yoghurts can be used as part of your baby’s meals.

For bottle fed babies, about 500ml (16-18 fl.oz.) of baby formula milk should be offered to your baby every day. When your baby is eight months old or older, you may wish to change his/her bottle milk to a follow-on milk formula, e.g. Cow & Gate Step-up, Milupa Forward, Farley's Follow-on Milk or SMA Progress.

Please note: Breast milk, baby formula milk and follow-on milk formula are all called ‘baby milk’ in the rest of this booklet.
How to Begin

Remember you or a responsible adult should stay close to your baby during feeding to provide encouragement and to make sure your baby does not choke.

1. Continue to offer a meat meal every day.

2. Introduce foods mashed with a fork first.
   For example:
   - Potato mashed with butter and/or other vegetables, like carrot or broccoli,
   - Mashed banana with custard.

3. After a week or two, introduce cooked foods with soft lumps.
   For example:
   - Finely chopped carrot, cauliflower, or broccoli in meals with pureed meat and mashed potato or baby rice,
   - Chopped, stewed apple or pear with yoghurt or full fat fromage frais,
   - Finely chopped cauliflower with melted cheese,
   - Ready-prepared savoury meals, without meat, from the list on page 4.

4. Continue to puree home prepared meats until your baby can cope with soft lumpy foods. Continue to use 'First Stage' ready-made meat meals from Feeding guide 1.

5. New types of food can be gradually introduced, allow a few days between each new type of food.
   For example:
   - Wheat products, like pasta and regular rusks,
   - More fruits & vegetables, e.g. chopped ripe peach & chopped cooked cabbage,
   - Fish, which must be boneless, can be offered in pureed form to begin with,
   - Eggs, either boiled, scrambled or finely chopped after hard boiling.

6. When your baby is coping well with lumpy foods, introduce soft finger foods.
   For example:
   - A finger of buttered toast,
   - Cooked carrot sticks or cooked green beans,
   - Grated cheese.

7. After a month or two, your baby should be able to manage finely, minced meats. Try a softer meat such as chicken or liver first. Gradually offer all meat in minced form.
   For example:
   - Finely minced chicken with mashed potato and chopped carrot,
   - Finely minced lamb’s liver with mashed potato and chopped cabbage,
   - Finely minced lamb or beef with chopped, pasta and chopped, tinned tomato,
   - Ready-prepared savoury meals, with meat or fish, see list on pages 4 & 5.

8. Gradually introduce a wider range of finger foods.
   For example:
   - A finger of buttered bread,
   - Slices of ripe, peeled fruits, such as peach, banana, or apple,
   - Half of a rusk, Fingers of a hard cheese, like cheddar.
Ready-Prepared Baby Foods for Use in Stage 2

BREAKFASTS:

In Packets.  
Farley's-  
Cow & Gate-  
Organix-  
Weetabix*  
Ready Brek*  

In Jars or Cans.  
Cow & Gate-  
Cow & Gate, Organic Choice-  

To be mixed with baby milk.

Rusks* and Gluten Free Rusks
Farex
Sunshine Banana Cereal
Banana, Orange & Yoghurt
Banana, Apple & Orange
Banana porridge*

Creamed Porridge*
Harvest Cereals*
Yoghurt with Orange & Banana
Fruit Surprise*

All Junior Choice Breakfasts*

Creamed Porridge*
Apple & Banana Cereal*
Mixed Fruit Muesli*

Creamed Porridge Oats*
7 Cereals*
Oat Cereal with Apple*
All Fruit Breakfasts

Swiss Muesli*
Apple & Pear*
Pineapple & Raspberry

Fruit & Porridge Breakfast*
Fruit & Muesli Breakfast*

Creamed Oat Porridge*
Creamy Oatmeal Porridge*
**SAVOURY MEALS FOR LUNCH OR TEA:**

All savoury meals listed in Feeding Guide 1.

**WITHOUT MEAT OR FISH:**

<table>
<thead>
<tr>
<th><strong>In Packets</strong></th>
<th><strong>In Jars or Cans</strong></th>
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</table>
| **Cow & gate**-  
  Summer Vegetables  
  Cheese & Tomato Pasta* | **Cow & gate**-  
  Vegetables & Macaroni Cheese*  
  Cauliflower Gratin  
  Winter Vegetable & Cheese  
  Cheesy Vegetables & Pasta |
| **Farley’s**-  
  Cheesy Vegetable Pasta* | **Heinz**-  
  Cheesy Broccoli & Potato Bake  
  Country Vegetable with Mushrooms  
  Cheesy Pasta & Vegetables*  
  Vegetable, Tomato & Pasta Bake*  
  Cauliflower Cheese Pasta with Potatoes* |
| **Milupa**-  
  Cheesy Tomato Pasta*  
  Leek, Potato with Sweetcorn | **Boots**-  
  Teatime Cheese & Pasta* |
| **Boots**-  
  Vegetable & Cheese Mornay  
  Cheese, Spinach & Potato Bake  
  Teatime Savoury Sweetcorn | **Boots, International**-  
  Vegetable Ratatouille  
  Vegetable Jambalaya |
| **Organix**-  
  Vegetable & Cheese Cereal |  |

**WITH MEAT:**

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<tr>
<th><strong>In Packets</strong></th>
<th><strong>In Jars or Cans</strong></th>
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| **Cow & Gate**-  
  Seasonal Vegetable with Chicken  
  Winter Hotpot  
  Farmhouse Vegetable with Lamb  
  Spaghetti Bolognese*  
  Sage & Turkey Casserole | **Cow & Gate**-  
  Vegetable & Lamb Cassoulet*  
  Pasta Italienne with Pork*  
  Pasta Bolognese*  
  Mediterranean Vegetable & Lamb Risotto  
  Primavera Chicken Risotto*  
  Vegetable & Turkey Pot au Feu  
  Vegetable & Chicken Cassoulet*  
  Goulash  
  Chow Mein  
  Sunday Lunch  
  Spaghetti Bolognese* |
| **Farley’s**-  
  Chicken & Mushroom Supreme  
  Shepherds Pie with Lamb  
  Golden Veg. & Chicken* | **Heinz**-  
  Farmhouse Vegetable & Pork  
  Garden Vegetable & Chicken  
  Vegetable & Turkey Casserole*  
  Spaghetti & Pork Sausage*  
  Fruity Vegetable & Chicken Risotto |
| **Milupa**-  
  Turkey Supreme  
  Chicken a la King  
  Tomato & Steak Hotpot  
  Pasta Bolognese* | **All Pasta meals (from 7 months)***  

Harvest Vegetables & Chicken

Potato, Cauliflower with Tender Lamb*
Country Veg./Chicken & Mushrooms*

**In Packets**

Boots-
Traditional Beef Dinner
Vegetable & Chicken Casserole

**In Jars or Cans**

Boots, Junior Range-
Chicken & Noodles*
Spaghetti Bolognaise*

Boots, International Range-
All- Dishes with Pasta *

Boots, First Harvest Range-
All* except Country Chicken with Veg.

Boots, Mother’s Recipe-
Garden Vegetables with Steak

WITH FISH:

**In Packets**

Farley’s-
Vegetable & Salmon Bake

**In Jars or Cans**

Cow & Gate-
Mediterranean Fish feast*
Paella

Heinz-
Fisherman’s Pie
Pasta with Tuna & Garden Vegetables*

Boots, International Range-
Paella
Potato, Salmon & Herbs á Crème

Useful Extras:

**Pasta:**

**In Packets**

Boots, Mother’s Recipe-
Pasta*

Organix-
Pasta Stars*

**Sauce Mixes:**

Gravy and flavoured sauce mixes, which are made especially for babies, can be used
to moisten and add flavour to savoury dishes. **Do not use baby milk to make up a packet sauce mix.** Make up and use the gravy, cheese or mushroom sauce mix as
directed on the packet or jar. These can be used from 9 months of age.

**In Packets**

Milupa-
Gravy
Cheese Sauce

**In Jars**

Organix-
Tomato & Cheese
Mushroom
PUDDINGS FOR LUNCH OR TEA:

All puddings listed in Feeding Guide 1.

In Packets

Cow & Gate-
  Apple Crumble*

Farley’s-
  Banana Fool
  Apricot & Apple Crumble*
  Pear & Blackberry Dessert

Boots-
  Chocolate Delight
  Tropical Fruit Salad
  Banana & Orange Surprise

Organix-
  Fruity Rice Pudding
  Banana & Chocolate
  Banana, Apple & Orange

In Jars or Cans

Cow & Gate-
  Traditional Egg Custard*
  Traditional Rice Pudding
  Pineapple & Banana Custard*
  Banana & Apple Custard*
  Orange & Banana Dream*
  Strawberry & Banana Dream*
  Chocolate Dream
  Caribbean Fruit Fool*

Cow & Gate, Organic Choice-
  Rice Pudding with Nutmeg & Vanilla

Heinz-
  Egg Custard with Rice
  Crème Caramel*
  Egg Custard with Apple

Boots-
  Egg Custard & Egg Custard with Apple
  Crème Caramel
  Rice Pudding with Nutmeg

Boots, First Harvest-
  Fruit Salad
  Apple & Mango Dessert
  Banana & Yoghurt Surprise*
  Creamy Pear Pudding*
  DairyRice Dessert+Maple Syrup*

Boots, Mother’s Recipe-
  Banana Dessert
  Apple, Peach & Rice Dessert

* These foods contain wheat flour or gluten.

Once your baby has accepted a food containing wheat flour e.g. pasta, regular rusks or bread, all the foods with an asterix (*) next to the name can be used.

All packet foods should be made up as directed on the packet. If a particular packet food can be mixed with baby milk or boiled water, use baby milk, otherwise mix to the correct thickness with boiled water.
HOW TO PREPARE FOODS

Milk for Mixing

- **Baby formula milk or breast milk:**
  Cereals, which can be mixed with milk (see list under **Breakfasts**), and home-prepared foods should be mixed with enough of the baby milk you use as your baby’s main drink, to make a thick creamy mix.

- **Follow-on milk:**
  Once your baby is eight months old or older, you may choose to give him/her a follow-on milk as his/her main milk drink. Cow & Gate Step-up, Milupa Forward and SMA Progress are all follow-on milks. The follow-on milk can then be used to mix with breakfast cereals and home-prepared foods.

Preparation

- All home-prepared foods should be cooked without the addition of salt.

- Regular gravies and adult, ready-made, savoury sauces contain too much salt for young babies and should not be used. Milupa gravy and cheese sauce can be used.

- All foods offered in the first week or two should have the consistency of mashed potato. Home-prepared foods can be pureed by using a food processor, sieve, or a Baby Mouli. Cooked vegetables and bananas can be mashed. As your baby progresses, foods can be minced or finely chopped. When your baby is ready for minced foods, these can be prepared with a hand mincer or the mincing blade of a food processor.

- All foods, apart from cold puddings, should be warm, not hot! Stir foods and test their temperature before feeding them to your baby. It is especially important to stir food thoroughly, if you cook by microwave.

- All foods should be freshly prepared just before a feed. Any leftovers must be thrown away. However, it is safe to cook vegetables with or without meat in batches. The food not for immediate consumption should be quickly cooled and then frozen for future use. It may be stored for up to one month. It should be thoroughly defrosted in a refrigerator for several hours, and quickly warmed, immediately before use.

- Don’t add any solids to a bottle. All food must be given on a spoon or as a finger food.

- When using shop bought, ready prepared baby foods, **first stage and second stage baby foods** can be offered to your baby. First stage baby foods will say “Recommended for babies from 4 months old” on the jar, tin or packet, second stage baby foods will say “Recommended for babies from 7 months old” on the jar, tin or packet.

Timing

- Allow your baby to set the pace. If a food is refused, try again in a week or two. Let your baby decide how much of each meal he/she wants to eat.

- **Finger foods** can be given as part of a meal, e.g. a toast soldier as part of breakfast, or as a snack between meals, e.g. slices of banana or peach at mid morning.
Suggested Daily Menus at the Start of the Second Stage

Breakfast;
Rusk made with baby milk,
or
Sunshine banana cereal made with baby milk,
or
Baby porridge made with boiled water.

Lunch:
Main Course
Mashed potato, finely chopped, well cooked broccoli and pureed chicken, mixed with baby milk,
or
Baby rice, finely chopped, well cooked carrot and pureed lamb, mixed with baby milk,
or
Any first or second stage baby main meal from the recommended list.

Pudding
Mashed banana,
or
Finely chopped stewed apple with fromage frais,
or
Any first or second stage baby pudding from the recommended list.

Tea or Supper:
Main Course
Mashed or finely chopped, well cooked cauliflower with melted cheese,
or
Well cooked rice with finely chopped tinned tomatoes and melted cheese,
or
Any first or second stage baby savoury meal from the recommended list.

Pudding
If required, as for lunch.

Snacks:
These may be given as part of the meal or as a snack between meals.
A finger of buttered toast,
Cooked carrot sticks,
Grated cheese,
Baby yoghurt from the recommended list,

Milk/Drinks:
Offer breast or formula milk or a drink from the recommended ‘Drinks’ list (page 10) with meals. Offer breast or formula milk on waking and before bedtime.
Suggested Daily Menus for Later in the Second Stage

Breakfast:
- Rusk made with baby milk, and buttered toast fingers,
  or
- Baby porridge made with boiled water, and bread and butter fingers,
  or
- Weetabix made with baby milk, and banana slices or yoghurt.

Lunch:
- **Main Course**
  - Shepherd’s pie (minced lamb, mashed potato, Milupa gravy) with chopped cabbage,
    or
  - Boiled rice, chopped carrot and minced chicken in a baby milk sauce,
    or
  - Chopped pasta, minced beef, chopped broccoli with tinned, chopped tomato,
    or
  - Any second stage baby main meal from the recommended list.

- **Pudding**
  - Chopped banana or cooked apple and custard,
    or
  - Rice pudding,
    or
  - Chopped ripe peach, strawberries or slices of peeled apple
    or
  - Any first or second stage baby pudding from the recommended list.

Tea or Supper:
- **Main Course**
  - A boiled egg and toast soldiers
    or
  - Mashed boiled white fish/chopped fish finger with chopped, tinned tomato,
    or
  - Scrambled egg and chopped tomato,
    or
  - Chopped, cooked cauliflower with mashed pasta and Milupa cheese sauce,
    or
  - Any first or second stage baby savoury meal from the recommended list.

- **Pudding**
  - If required, as for lunch

Snacks:
- **These may be given as part of the meal or as a snack between meals.**
  - Fingers of buttered toast, bread and butter soldiers and rusks.
  - Fingers of hard cheese, cooked carrot sticks and slices of peeled fruit.
  - Baby yoghurts from the recommended list.

Milk/Drinks:
- Offer breast or formula milk or a drink from the recommended ‘Drinks’ list (page 10) with meals. Offer breast or formula milk on waking and before bedtime.
DRINKS

FROM 6 MONTHS TO 1 YEAR

Baby Milk
This will still provide a large proportion of the food and drink for a baby up to 12 months of age. Breast milk, an infant formula milk or a follow-on milk are the only suitable baby milks for this age group.

Cow's milk (doorstep milk) is not a suitable drink for babies under one year of age.

Boiled Water
Cooled, boiled water should be offered after a milk or solid feed or between feeds, to a baby who seems thirsty. Offer water in hot weather or when your baby seems feverish or irritable.

Bottled fizzy waters and 'natural mineral water' are not suitable for babies.

Bottled, still spring water may be used, but it should still be boiled and cooled before use.

Purified Waters With a Hint of Flavour
Purified water with a hint of fruit flavour produced especially for babies, e.g. by Boots and Heinz, can be offered instead of plain, boiled water.

Baby Fruit Drinks
These should be used only at meal times, after the solid part of the meal has been given. They should preferably be given in a cup, they are acidic and contain sugar, which may cause tooth decay.

Concentrated drinks should be made up according to the manufacturer's instructions.

Baby herbal drinks should only be used occasionally.

Pure Fruit Juices
The pure fruit juices available in various flavours for adults can be offered to babies from 8 months of age. They must be diluted, use one part of the juice diluted with 10 parts of cooled, boiled water.

These should be used only at meal times, after the solid part of the meal has been given. They should be given in a cup, they are acidic and contain sugar, which may cause tooth decay.

Other Drinks
All other drinks, including squashes, soft drinks, diet drinks, fizzy drinks, flavoured milks, tea and coffee, are not suitable for babies under one year of age. They should be avoided.
Introduce as wide a range of foods as possible. The wider the range of foods you introduce, especially fruits, vegetables and meats, the less fussy your child will be about eating. If your child refuses a particular food, offer something he/she has already accepted, and try the new food in a week or two. Make sure your baby eats more savoury than sweet foods. If your baby will only accept a very small amount of food, offer milk feeds and solid foods at different times. If your baby seems particularly hungry, offer a pudding as well as a savoury dish. When your baby is able to hold a spoon, let him/her have a spoon for part of meal times. Guide his/her hand and let him/her start to feed him/herself. This will be very messy!

Foods to avoid until at least one year of age.

Salt. A small baby’s system can’t cope with more salt than that found in foods naturally.
Honey. Very occasionally honey can contain spores which can cause very serious disease in small babies. It should not be given to babies under one year old.
Nuts and Nut products. Nuts should not be given to babies before 5 years of age. Nut products, such as nut spreads and peanut butter should be avoided until 1 year.
Foods more likely to upset a baby’s system or cause an allergic reaction are:
- Eggs
- Citrus fruits
- Fish
- Cow’s milk
- Wheat based foods or cereal foods which contain gluten

Introduce these foods one at a time and check they do not cause any adverse reaction. Do not give a particular food again if you think your baby reacted badly to it, until you have consulted your doctor or your health visitor. Cow’s milk should only be used in cooking, e.g. to make custard, rice pudding or egg custard, not as a drink.

Readiness for the Next Stage:

Your baby should be at least 10-11 months old.
Your baby should be able to feed him/herself finger foods in a high chair.
Your baby should be able to eat minced meat and small lumps of other foods.
Your baby should be able to put a spoon with food on it into his/her mouth.
Your baby enjoys eating, at times, with the rest of the family.

If you have any queries about the information in this booklet, or you are ready for your copy of Feeding Guidelines III, please contact:
Lynne Marriott, School of Biological Sciences, University of Surrey, Guildford GU2 5XH
Telephone 01962 620975
UNIVERSITY OF SURREY

PRETERM FEEDING STUDY

THIRD
FEEDING GUIDE
FOR PARENTS
THE THIRD STAGE OF WEANING

STAGE THREE OF WEANING

In stage three of weaning, it is time to extend your baby's eating experiences, so that he/she can eat the same foods as the rest of the family. He/she will already have been introduced to and accepted quite a wide range of different foods. He/she will now be coping well with eating minced food and finger foods.

In this stage of weaning, you can start to give your baby most of the foods you eat yourself. To begin with all foods should be minced or given as finger sized pieces. Special care should be taken to remove any bones, hard lumps or pieces of food, which are difficult to chew. Gradually you can introduce chopped food instead of minced food.

WHEN TO START

1. Your baby should be at least 10-15 months old.
2. Your baby should be eating a variety of minced foods, including minced meat or minced pulses.
3. Your baby should be able to eat a variety of finger foods.
4. Your baby should be able to begin to feed himself/herself with a spoon.
5. You feel your baby is ready to cope with new experiences.

When your baby has reached, the age and stages above and you feel he/she is ready, then you should begin the third stage of weaning.

MILK FEEDS:

Your baby should continue to receive breast milk or baby formula milk, as his/her main drink until he/she is one year past the date when he/she was expected to be born. Give this milk to your baby as his/her main drink several times a day. For bottle fed babies, about 500 ml (1 pint) of baby formula milk should be offered to your baby every day. This can be reduced to about 350ml (½ pint) after one year of age.

Cow's milk (normal, doorstep milk) should not be used as a drink until one year past your baby's expected date of delivery.

Cow's milk can be used in cooking before your baby is one year old. Cow's milk can be used for mixing with dry foods, such as breakfast cereals, from when your baby is one year old.

For babies and toddlers, use whole (full cream) cow's milk not semi skimmed or skimmed milk.

Please note: Breast milk, baby formula milk and follow-on baby formula milk are all called 'baby milk' in this booklet.
HOW TO BEGIN

Remember you or a responsible adult should stay close to your baby during feeding to provide encouragement and to make sure your baby does not choke.

1. Continue to offer your baby at least one meal, which contains meat or fish every day.

2. Introduce a small portion of family food, with all parts minced or chopped into small pieces.
   For example:
   - Potato, vegetables and chicken casserole,
   - Sausages (low salt) and baked beans (low salt)
   - Fruit pie with custard.

3. New types of meals can be gradually introduced. Let your baby share more regular family meals and mealtimes as he/she progresses with different kinds of meals.

4. Gradually offer different sorts of family dishes to your baby.
   For example:
   - Roast meals, casseroles, pasta dishes, pies and baked tarts.

5. Start chopping the softer parts of each meal. When your baby is used to lots of soft chopped food, give meat and raw vegetables in small chopped pieces.

6. Encourage your baby to feed himself/herself with a spoon.

7. Gradually introduce a wider range of finger foods.
   For example:
   - Raw vegetable sticks,
   - Fresh fruit slices,
   - Sandwich fingers,
   - Small slices of soft pizza,
   - Squares of melted cheese on toast,
   - Plain biscuits,
   - Plain or cheese crackers,
   - A slice of cake (nut free).
Milk for Mixing

- **Baby Milk:**
  Cereals, which can be mixed with milk, should be mixed with your baby's regular milk until your baby is one year old. Baby milks called follow-on milks are produced for older babies, e.g. Cow & Gate Step-up, Milupa Forward and SMA Progress. These can be used as your baby's regular milk, if he/she is not breast fed, and can also be used for mixing with other foods.

- **Cow's Milk:**
  **When your baby is 12 months old,** you can start to use regular, whole cow’s milk for mixing with breakfast cereals and home-prepared foods, rather than baby milk. All babies and toddlers should be given ‘whole milk’ not semi-skimmed or skimmed milk.

Preparation

- **All foods, apart from cold puddings, should be warm, but not hot!** Stir foods and test their temperature before feeding them to your baby. It is especially important to stir food thoroughly if you heat it in a microwave.

- **All foods should be freshly prepared just before a meal. Any leftovers must be thrown away.** However, it is safe to cook meals in batches. The food not for immediate consumption should be quickly cooled and then frozen for future use. When you are ready to use it, it should be thoroughly defrosted in a refrigerator for several hours and thoroughly warmed, immediately before serving.

- **When using shop bought, ready prepared baby foods, ‘Second Stage’ baby foods can be offered to your baby.** Second stage baby foods will say “Recommended for babies from 7 months old” on the jar, tin or packet.

- **When your baby is at least one year of age ‘Toddler Stage’ baby foods can be used.** These will say “Recommended for babies from one year old” on the jar, tin or packet. See the list of recommended foods on page 6 of this guide.

- **Full fat varieties of yoghurt, fromage frais and milk should be used in meal preparation.**

- **Low salt varieties of baked beans, sausages and pre-cooked spaghetti should ideally be used in meal preparation**

- **All home-prepared foods should be cooked without the addition of salt.**

- **Regular gravies and adult, ready-made, savoury sauces contain a lot of salt and so only small amounts of these should be used in your baby’s meals.**

- **Finger foods can be given as part of a meal, e.g. toast soldiers as part of breakfast or as a snack between meals e.g. half a rusk or slices of fruit at mid morning.**
Suggested Daily Menus for the Start of the Third Stage

Breakfast;
Rusk with baby milk and buttered toast fingers,
or
Boiled egg with bread and butter soldiers,
or
Weetabix with baby milk.

Lunch:
Main Course
Mashed potato, chopped, cooked carrots, minced chicken and gravy,
or
Chopped pasta with bolognaise sauce,
or
Chopped roast potatoes, chopped cauliflower in cheese sauce and minced lamb.
Pudding
Stewed fruit (chopped) and custard,
or
Rice pudding.

Tea or Supper:
Main Course
Cheese on toast squares with chopped tomato,
or
Chopped fish finger with baked beans,
or
Scrambled egg with tinned spaghetti.
Pudding
Fresh fruit slices and/or yoghurt.

Second stage breakfasts, savoury meals and puddings from the recommended list in the Second Feeding Guide can also be used.

Snacks:
These may be given as part of the meal or as a snack between meals.
Fingers of buttered bread or toast,
Raw vegetable sticks,
Slices of fruit,
A plain cracker or a biscuit,
Baby fruit drink, water or diluted fruit juice.

Drinks:
Offer breast or formula milk with meals or on waking and before bedtime.
Water, a baby fruit drink or diluted fruit juice may be offered with one or two meals.
Suggested Daily Menus for Later in the Third Stage

Breakfast:
  Weetabix mixed with cow’s milk, and buttered toast fingers,
  or
  Porridge made with cow’s milk,
  or
  Rice Krispies or Shreddies mixed with cow’s milk,
  or
  Egg, small pieces of grilled, lean bacon, grilled tomato and bread fingers.

Lunch:
  **Main Course**
  Lancashire Hotpot (chopped lamb, potato slices, chopped onion and gravy)
  with chopped cabbage,
  or
  Boiled rice, peas and chopped chicken in a tomato or tangy sauce,
  or
  Chopped, roast beef, chopped broccoli with mashed potatoes and gravy.

  **Pudding**
  Small pieces of apple pie and custard,
  or
  Jelly and ice cream,
  or
  Sliced peach and fromage frais,
  or
  Fresh fruit.

Tea or Supper:
  **Main Course**
  Sandwich squares made with e.g. cheese, tuna or banana,
  or
  Small slices of soft pizza and slices of fresh tomato,
  or
  Scrambled egg with baked beans,
  or
  Vegetable soup with a soft bread roll.

  **Pudding**
  Apple or orange slices and/or fruit yoghurt.

Toddler stage meals and puddings from the recommended list (page 6) can also be used.

Snacks:
  These may be given as part of a meal or as a snack between meals. See page 4.

Milk:
  Offer baby milk, cow’s milk, water or diluted fruit juice with meals, or as required.
TODDLER STAGE BABY FOODS

These meals are suitable for toddlers aged between one and two years.

Cow & Gate Olivarit Toddler Meals-
- Spaghetti Bolognaise
- Vegetable & Salmon Gratin
- Pasta Neapolitan
- Summer Vegetable & Chicken Cassoulet
- Broccoli & Turkey Cassoulet
- Juicy Fruity Pasta & Pork

Summer Orchard Crumble
Apple Pie & Banana Custard
Exotic Fruit Compote

Cow & Gate Toddler Meals-
- Pasta Bolognese
- Vegetable & Turkey Casserole

Heinz Junior Cuisine-
- Country Vegetables & Chicken
- Pasta in a Creamy Bacon & Cheese Sauce
- Sunday Lunch, Garden Vegetables & Lamb

Apple & Mango Crumble
Bread & Butter Style Pudding with Juicy Sultanas

Boots Toddler Meals in Jars-
- Farmhouse Vegetables & Ham Hotpot
- Country Vegetables & Beef

Boots International Range for Toddlers-
- Raviolo
- Mexican Chicken
- Pasta & Salmon Florentine
- Teriyaki Chicken

Boots Mothers Recipe for Toddlers-
- Country Chicken with Vegetables & Rice
- Spaghetti Bolognaise

Boots Heart Package-
- Spaghetti & Chicken
- Ham & Apple
- Turkey Bolognaise Sauce

Baby Organix-
- Pasta ABC and Pasta Ducks
HEALTHY EATING ADVICE FOR TODDLERS AND SMALL CHILDREN

1. Milk/Dairy Products:
Give at least 350 ml (½ pint) of milk or 2 servings of a dairy product (cheese, yoghurt, milk pudding or fromage frais) every day.
Use whole milk and full fat dairy products.
Soft cheeses can be given after 15 months of age.

2. Starchy Foods:
Include at least one serving of bread, breakfast cereals, pastry, potato, rice or pasta with every meal.
Wholemeal bread, pasta and cereals may be introduced after 15 months of age.

3. Vegetables and Fruits
Try and include at least 4 servings of fruit/vegetable every day.
One serving for a small child is equal to 1 tablespoonful of a cooked or sliced fruit/vegetable, between ½-1 piece of larger, raw fruits, e.g. apple or orange, and 3-4 small fruits e.g. strawberries.
Including a fruit or vegetable with the main meal will improve the absorption of iron from the meal. This is very important for good health and development.

4. Meat, Fish and Meat Alternatives
Include meat, fish or a meat alternative, e.g. egg or pulses, in at least one meal every day.
Oily fish e.g. sardine, herring and mackerel are very good for growing children.
Trim the fat off the meat before serving. Use little or no added fat when cooking meat.
Small amounts of processed meats, such as liver paté, can be used after 15 months of age.

5. Meal Patterns
Encourage your child to eat three meals a day. If a snack is needed, offer fruit, yoghurt, plain crackers, a plain biscuit or lightly buttered bread. Do not let your child become dependent on salty, high fat processed foods, sweets, cakes and biscuits for a large part of his/her daily food intake. A drink of milk at bedtime is a good idea nutritionally and may encourage good sleep habits.

6. Occasional Foods
Try and keep high fat, salty foods, e.g. crisps and processed snack foods, as an occasional treat.
Similarly, foods with a lot of added sugar, e.g. sweets, cakes and chocolate bars, should be given as treats once a day or less.

7. Drinks
Milk, water, baby fruit drinks and diluted fruit juices are the most suitable liquids for toddlers. Fizzy drinks and fruit squashes both contain a lot of dissolved sugar or artificial sweeteners, such as saccharin, and are not suitable for toddlers.
Tea and coffee reduce the absorption of iron and are not suitable for toddlers.
Give fruit juice and ‘baby drinks’ in a cup rather than in a bottle to avoid tooth decay.
APPENDIX VII

Milk Diaries for Breast and Bottle-fed Infants

Note on diary construction:

The diaries were constructed by printing the pages in landscape format and then folding in half.

Inclusions in Appendix:

1. The cover for both diaries is included.

2. The instruction page, a completed sample page, a blank page for completion and the supplements page for breast-fed babies are included in the appendix.

3. The instruction page, a completed sample page, a blank page for completion and the supplements page for bottle-fed babies are included in the appendix.
Write down the name and dose of any vitamin or mineral supplements.

<table>
<thead>
<tr>
<th>Name of vitamin drops:</th>
<th>Dose:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle the days the drops were given:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of mineral drops:</th>
<th>Dose:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle the days the drops were given:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

Any other information you think will be useful.

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### How to fill in your baby’s milk diary

1. Please remember to write down every feed your baby has.

2. Please don’t change your normal pattern of feeding, or the amount of time your baby feeds.

3. Please record the total amount of time your baby suckles on each breast in *Table 1*. If baby falls asleep for a few minutes, don’t count that time as feeding time.

4. If baby brings back any of the milk or is sick, record this with a tick in the ‘*regurgitated feed*’ column. The approximate amount of liquid (in teaspoonfuls or tablespoonfuls) brought back should be given in the next column.

5. If you give your baby one or more bottle feeds, please give the details in *Baby Milk Formula Feeding, Table 2*.

6. When the bottle of milk is prepared, please write down the volume of milk in the bottle in the ‘*start volume*’ column of the diary, eg 100mls. When your baby has finished feeding, write down the level of the milk left in the bottle in the ‘*finish volume*’ column.

7. If you give your baby any other drinks, write down the name of the drink and the amount in the ‘*Other Drinks*, Table 3.’

8. Write down the details of any vitamin or mineral supplements you give your baby at the end of the diary.

9. Please start each day on a new page.

10. On the next page, there is an example of how to fill in the diary. If you have any questions, call Lynne Marriott 01962 620975.
Day of the Week: Monday

Table I. Breast Milk Feeding Times.

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Length of Time on First Breast in Minutes</th>
<th>Length of Time on Second Breast in Minutes</th>
<th>Regurgitated</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.15am</td>
<td>8</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.10</td>
<td>12</td>
<td>9</td>
<td>✔</td>
<td>2tsp</td>
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<tr>
<td>10.30</td>
<td>7</td>
<td>10</td>
<td></td>
<td></td>
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<tr>
<td>1.15pm</td>
<td>10</td>
<td>9</td>
<td></td>
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<td>4.30</td>
<td>8</td>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td>6.15</td>
<td>10</td>
<td>10</td>
<td>✔</td>
<td>1tsp</td>
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<tr>
<td>10.45</td>
<td>10</td>
<td>6</td>
<td></td>
<td></td>
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</tbody>
</table>

Table 2. Baby Milk Formula Feeding.

Name of Formula:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Start Volume (no. of mls)</th>
<th>Finish Volume (no. of mls)</th>
<th>Regurgitated</th>
<th>Amount</th>
</tr>
</thead>
</table>

Table 3. Other Drinks.

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Name of Drink</th>
<th>Start Volume (no. of mls)</th>
<th>Finish Volume (no. of mls)</th>
<th>Regurgitated</th>
<th>Amount</th>
</tr>
</thead>
</table>
Table I. Breast Milk Feeding Times.

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Length of Time on First Breast in Minutes</th>
<th>Length of Time on Second Breast in Minutes</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
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</table>

Table 2. Baby Milk Formula Feeding.

Name of Formula:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Start Volume (no. of mls)</th>
<th>Finish Volume (no. of mls)</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
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<tbody>
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</table>

Table 3. Other Drinks.

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Name of Drink (no. of mls)</th>
<th>Start Volume (no. of mls)</th>
<th>Finish (no. of mls)</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
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</tbody>
</table>
Write down the name and dose of any vitamin or mineral supplements.

Name of vitamin drops:  

Name of mineral drops:  

Circle days given:  1 2 3 4 5 6 7

How to fill in your baby’s milk diary

1. Please remember to write down every feed your baby has.

2. Please don’t change your normal pattern of feeding, or the amount of milk your baby is offered.

3. When the bottle of milk is prepared, please write down the volume of milk in the bottle in the ‘start volume’ column of the baby milk table of the diary, eg 100mls.

4. When your baby has finished feeding, write down the level of the milk left in the bottle in the ‘finish volume’ column. This record of the volume of milk left over, allows us to calculate how much the baby has drunk. Record zero if your baby drinks all the milk.

5. If baby brings back any of the milk or is sick, record this with a tick in the ‘regurgitated feed’ column. The approximate amount of liquid (in teaspoonfuls or tablespoonfuls) brought back should be given in the next column.

6. If anyone else feeds your baby, please make sure that the diary is correctly filled in.

7. If you give your baby any other drinks, write down the name and the amount in the ‘other drinks’ table.

8. Please start each day on a new page.

9. On the next page, there is an example of how to fill in the diary. If you have any questions, call Lynne Marriott 01962 620975.

10. Please write down the name and number of drops per day of any vitamin or mineral supplements you give baby, on the back page.
**Day of the Week:** Monday  
**Date:** 9/2/98  
**Type of Baby Milk:** Cow & Gate Premium

<table>
<thead>
<tr>
<th>Time</th>
<th>Start Volume (no. of mls of milk in bottle)</th>
<th>Finish Volume (no. of mls of milk in bottle)</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.15 am</td>
<td>125</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.50</td>
<td>100</td>
<td>15</td>
<td>✓</td>
<td>2tsp</td>
<td></td>
</tr>
<tr>
<td>12.10 pm</td>
<td>100</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4.00</td>
<td>100</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.30</td>
<td>100</td>
<td>40</td>
<td>✓</td>
<td>3tsp</td>
<td></td>
</tr>
<tr>
<td>8.00</td>
<td>100</td>
<td>25</td>
<td>✓</td>
<td>2tbs</td>
<td></td>
</tr>
<tr>
<td>11.30 pm</td>
<td>125</td>
<td>20</td>
<td></td>
<td></td>
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</tbody>
</table>

**Other Drinks:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Time of Day</th>
<th>Start Volume (no. of mls)</th>
<th>Finish Volume (no. of mls)</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiled water</td>
<td>8.30 pm</td>
<td>50</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BABY

FOOD DIARY

Baby's Name
HOW TO FILL IN YOUR BABY'S FOOD DIARY

Please write down everything your baby eats for seven consecutive days. This includes all milk drinks, other drinks and snacks, as well as meals. Please give as much information as you can, about what your baby eats and how much he/she eats.
If your baby eats any food away from home, note down a description of all the food eaten to enter into the diary later and estimate the amount eaten in teaspoonfuls or tablespoonfuls. Please start each day on a new page.
On page 3, there is an example of how to fill in the diary.

Please do not alter your baby's feeding routine to fit in with keeping the diary.

USING THE DIARY

How to fill in the Baby Food Table

Column 1: The three main meals of the day and snacks are written here.

Column 2: For shop bought baby foods, just give the maker’s name and the name of the food. For home prepared foods, write down all the ingredients you have used.

Column 3: Write down the cooking method for any home cooked food.

Column 4: For each food, weigh the food before you offer it to your baby and write down the weight here. For home prepared foods, as you add each part of the meal to the baby’s dish, record the weight in this column.

Column 5: Note the weight of any leftovers of the whole meal here.

How to fill in the Drinks Table

Column 1: Note down the time of any drinks given.

Column 2: Note down the names of any drinks given.

Column 3: For a drink given in a bottle, weigh the bottle before the baby drinks and note down the weight of the bottle and contents. For a drink given in a cup, weigh the cup and its contents before the baby drinks. For breastfeeds, record the total amount of time in minutes that the baby suckles at each feed. The feeding time can be written in the weight column in the ‘drinks’ section.

Column 4: For a drink given in a bottle, weigh the bottle after the baby finishes drinking and note down the weight of the bottle with any liquid left in it. For a drink given in a cup, weigh the cup and its contents after the baby finishes drinking.
USING THE SCALES

1. Place the scales on a flat surface.

2. Press the ‘on/zero’ button. The display will show 8888 7/8.

3. Select the Metric Scale (kg and g). The display will show 0g.

4. Place the baby’s dish or plate on the scale and press the ‘on/zero’ button again. The scale should reset to zero.

5. Add the first ingredient of the baby food to the dish and record the weight in column 4 of the diary.

6. Press the ‘on/zero’ button to reset the scale to zero again.

7. After adding each ingredient to the scale and recording its weight in column 4, press the ‘on/zero’ button to reset the scale to zero. This will give the weight of each part of a particular meal.

8. To weigh any leftovers, place a plate on the scales, press ‘zero’, and spoon the leftovers onto it, or subtract the weight of the empty dish from the weight of the dish + leftovers.

9. If you are feeding directly from the jar, just write down the weight of the jar and contents before and after feeding in columns 4 & 5.

10. Bottles and cups can be weighed directly on the scales.

11. Remember to press the ‘off’ button when you have finished.

SHORT CUTS

Foods such as a whole rusk only need to be weighed once.
Any leftover food like part of a rusk should be weighed each time.

If you offer your baby the same amount of milk in a bottle each time, the full bottle only needs to be weighed once, the empty bottle should be weighed once too.
Any leftover milk in the bottle should be weighed each time.
Day of the Week: Monday

Date: 7/9/98

**SOLID BABY FOODS**

<table>
<thead>
<tr>
<th>Meal</th>
<th>Name and Description of Each Part of Meal</th>
<th>Cooking Method</th>
<th>Weight of Each Part</th>
<th>Weight of Leftovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>Farley’s Gluten Free Rusk with Baby Milk Buttered Toast Fingers</td>
<td></td>
<td>28g</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>44g 18g</td>
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<td></td>
<td>22g 12g</td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td>Pureed Chicken Mashed Potato Mashed Carrot Baby Milk Heinz Strawberry Yoghurt Dessert (jar)</td>
<td>roast boiled steamed</td>
<td>10g 35g 18g 25g 48g</td>
<td>34g 34g 18g 16g</td>
</tr>
<tr>
<td>Tea</td>
<td>C &amp; G Cheese &amp; Tomato Bake (pkt) Boiled Water Custard (Birds &amp; Cow’s Milk) Apple + Sugar</td>
<td></td>
<td>18g</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>44g 0g</td>
<td></td>
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<td></td>
<td>20g</td>
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<td></td>
<td>25g+3g 27g</td>
<td></td>
</tr>
<tr>
<td>Snacks</td>
<td>Cooked Carrot Sticks</td>
<td>steamed</td>
<td>26g</td>
<td>12g</td>
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</tbody>
</table>

**DRINKS**

<table>
<thead>
<tr>
<th>Time</th>
<th>Name of Drink</th>
<th>Start Weight of Bottle/Cup</th>
<th>Finish Weight of Bottle/Cup</th>
<th>Regurgitated Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.10am</td>
<td>SMA white</td>
<td>168g</td>
<td>48g (empty)</td>
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<tr>
<td>11.am</td>
<td>&quot;</td>
<td>&quot;</td>
<td>70g</td>
<td></td>
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<tr>
<td>12.15pm</td>
<td>Boots baby apple juice</td>
<td>98g</td>
<td>72g</td>
<td></td>
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<tr>
<td>4.00pm</td>
<td>SMA white</td>
<td>168g</td>
<td>48g</td>
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<tr>
<td>6.15pm</td>
<td>&quot;</td>
<td>&quot;</td>
<td>85g ✓ 2tsp</td>
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<tr>
<td>9.45pm</td>
<td>&quot;</td>
<td>198g</td>
<td>62g</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Meal</th>
<th>Name and Description of Each Part of Meal</th>
<th>Cooking Method</th>
<th>Weight of Each Part</th>
<th>Weight of Leftovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
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<td>Snacks</td>
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**DRINKS**

<table>
<thead>
<tr>
<th>Time</th>
<th>Name of Drink</th>
<th>Start Weight of Bottle/Cup</th>
<th>Finish Weight of Bottle/Cup</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
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4
# SOLID BABY FOODS

<table>
<thead>
<tr>
<th>Meal</th>
<th>Name and Description of Each Part of Meal</th>
<th>Cooking Method</th>
<th>Weight of Each Part</th>
<th>Weight of Leftovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
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<td>Snacks</td>
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## DRINKS

<table>
<thead>
<tr>
<th>Time</th>
<th>Name of Drink</th>
<th>Start Weight of Bottle/Cup</th>
<th>Finish Weight of Bottle/Cup</th>
<th>Regurgitated Yes</th>
<th>Amount</th>
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</table>
## SOLID BABY FOODS

<table>
<thead>
<tr>
<th>Meal</th>
<th>Name and Description of Each Part of Meal</th>
<th>Cooking Method</th>
<th>Weight of Each Part</th>
<th>Weight of Leftovers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
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<td><strong>Lunch</strong></td>
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<td><strong>Snacks</strong></td>
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## DRINKS

<table>
<thead>
<tr>
<th>Time</th>
<th>Name of Drink</th>
<th>Start Weight of Bottle/Cup</th>
<th>Finish Weight of Bottle/Cup</th>
<th>Regurgitated Yes</th>
<th>Amount</th>
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6
### SOLID BABY FOODS

<table>
<thead>
<tr>
<th>Meal</th>
<th>Name and Description of Each Part of Meal</th>
<th>Cooking Method</th>
<th>Weight of Each Part</th>
<th>Weight of Leftovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td></td>
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<td>Lunch</td>
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<td>Tea</td>
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<tr>
<td>Snacks</td>
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</table>

### DRINKS

<table>
<thead>
<tr>
<th>Time</th>
<th>Name of Drink</th>
<th>Start Weight of Bottle/Cup</th>
<th>Finish Weight of Bottle/Cup</th>
<th>Regurgitated</th>
<th>Yes</th>
<th>Amount</th>
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11
VITAMIN AND MINERAL DROPS

Write down the name and dose of any vitamin or mineral drops your baby takes here.

Names of Any Vitamin Drops:
Dose/Day:
Circle each day that vitamin drops were given: 1 2 3 4 5 6 7

Name of Any Mineral Drops:
Dose/Day:
Circle each day that mineral drops were given: 1 2 3 4 5 6 7

If you have any questions about filling in the diary or problems with the scales, call Lynne Marriott, 01962 620975.
APPENDIX IX

Nutriprem Leaflet
INFORMATION LEAFLET
FOR
PARENTS USING NUTRIPREM
IN THE
WEANING STUDY

For additional information about Nutriprem, please contact:
Lynne Marriott
School of Biological Sciences
University of Surrey
Guildford GU2 5XH
Tel. 01932 620975
NUTRIPREM is a special infant milk which can be used for mixing with specified cereals and home prepared baby foods for low birth weight infants.

Nutriprem has been specially developed for low birth weight infants. It provides energy and nutrient levels, which support growth rates with a lower volume intake than is required when either breast milk or regular infant milk is used. It is enriched with long chain polyunsaturated fatty acids (AA and DHA) and has added nucleotides, selenium and betacarotene. Nutriprem complies with the latest guidelines on preterm infant feeding.

It is usually used as a baby milk for low birth weight babies. In this research study it will be used to improve the level of very important nutrients in solid foods. Cereal baby foods and some home prepared baby foods are usually mixed with breast milk or baby formula milk, to give the correct consistency for babies. Nutriprem will be used instead of breast or formula milk to improve the nutrient content of baby cereals and some home prepared baby foods.

As it is being used in a research study, it will be used under medical supervision.

INGREDIENTS

Deminerolised water, lactose, vegetable oils, skimmed milk powder, maltodextrin, whey protein concentrate, egg lipid, milk fat, calcium citrate, calcium carbonate, sodium citrate, potassium citrate, vitamin C, inositol, marine oil, magnesium carbonate, sodium chloride, choline chloride, vitamin E, taurine, ferrous lactate, potassium hydroxide, nicotinamide, carnitine, zinc sulphate, cytidine-5 monophosphate, adenosine-5 monophosphate, calcium pantothenate, uridine-5 monophosphate, inosine-5 monophosphate, vitamin A, thiamin hydrochloride, riboflavin, copper sulphate, guanosine 5 monophosphate, vitamin B6, folic acid, β-carotene, potassium iodide, manganese sulphate, vitamin K, vitamin D, biotin, sodium selenite.

INSTRUCTIONS FOR USE

1. Check the best before date on the label.
2. Check the cap button. Do not use if the cap button can be depressed.
3. The milk can be used at room temperature or when warmed. To warm, mix the milk with the cereal or other food in a dish and stand the dish in a bowl of hot water for a couple of minutes. Stir the food, check the temperature and use immediately.
4. Do not heat the milk in a microwave.
5. Throw away any food that is not used, immediately. Leaving warm food standing around or rewarming food encourages bacteria and other dangerous organisms to grow in the food.
6. If you don’t need all the milk in a bottle for a meal, recap the bottle and place in a refrigerator at once. Any milk left in the bottle can be stored in a refrigerator with its cap on for up to 24 hours. The bottle and its contents must be thrown away once it has been opened for 24 hours.
7. Do not mix with dried baby foods (in boxes) unless the directions on the box say that the food can be made up using the baby’s regular milk.

STORAGE INSTRUCTIONS

Store in a cool dry place (4-25°C) away from direct sunlight.
APPENDIX X

Blood Sampling Protocol

**DR FOOTE’S PROTOCOL FOR PRETERM WEANING STUDY BLOOD COLLECTION**

**Timing:**
Between Sunday evening and Thursday afternoon

**Anaesthetic:**
Ametop with dressing cover

**Blood Volumes:**
- 0.5 ml in EDTA tube (red top)
- 1.0 ml in Li-heparin tube (orange top/1.3 ml)
- 1.0–1.5 ml in Li-heparin tube (white top/2.0 ml)

**Information on Tubes:**
Add date of sampling & ward.

**Information on envelopes:**
Add date of sampling, hospital, ward and sign.

**Delivery:**
Envelope which contains EDTA tube (red top) and Li-heparin tube (orange top/1.3 ml) should be sent/delivered as soon as possible to:
Royal Hampshire County Hospital
Romsey Rd. Winchester, SO22 5DG.

Envelope which contains Li-heparin tube (white top/2.0 ml) should be sent/delivered within 24 hours to:
Trace Elements Unit, Clinical Biochemistry,
Southampton General Hospital.
Appendix XI

Ethics Approvals
Dear Keith

In response to your letter of 20 January, this is the ethics committee situation regarding the studies with which you are involved:

1. THE LOW BIRTHWEIGHT INFANT AFTER HOSPITAL DISCHARGE: CURRENT FEEDING PRACTICES AND FUTURE NUTRITIONAL STRATEGIES

I confirm that Mr McGrand took Chair’s Action on 28 May 1997. I received the amendment from Mrs Marriott on 21 November re a change on page 9 of the questionnaire. This was subsequently minuted at our meeting on 9 December 1997. I apologise that you were not notified of our full approval earlier.

2. 003/97W: A COMPARATIVE STUDY TO ESTABLISH THE APPROPRIATE NUTRITIONAL STRATEGIES TO FOSTER OPTIMUM GROWTH AND DEVELOPMENT IN PRETERM INFANTS

The verbal response from you to my letter to Mrs Marriott dated 15 December (ref 003/97W/rb/9755) was discussed at the Ethics Committee meeting on 27 January. We were reassured about our earlier concerns and a letter was sent to Mrs Marriott on 2 February granting you full approval for the study.

The two amendments stated in Mrs Marriott’s letter dated 16 February were discussed at our meeting on 24 February, and approval was granted. However, we were concerned that we had particularly wanted reassurance that the weaning plan was
actually safe for preterm babies when we wrote for more details on 15 December, and it would appear from Professor Wharton’s comments that the original formulation was not suitable.

3. ETAC STUDY - PROTOCOL NO: MPCE93D 0602

I confirm that I sent a Chairman’s Action letter to you on 23 October. With changes in administration of the committee, this was omitted from the agenda at the following meeting on 9 December. It was subsequently discussed at our meeting on 24 February, but the committee are still not clear what will be done with the samples when the study has ended. Please send me written details so that this can be discussed at the next Ethics Committee meeting on 31 March.

Yours sincerely

Dr Matthew Dryden
Chairman, Winchester Local Research Ethics Committee

cc Mrs Lynn Marriott, Univ of Surrey
Dear Mrs Marriott

003/97W: A comparative study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants

Thank you for your letter dated 25th September advising the Ethics Committee of 2 amendments. I have looked at these and can give Chair’s Action approval. I would expect this to be ratified by the committee at its next meeting on 20 October. I will write to you again only if the members have any further comments.

Yours sincerely

Dr Matthew Dryden
Chairman - Winchester Local Research Ethics Committee
26 May 1998

Mrs L Marriott
School of Biological Sciences

Dear Mrs Marriott

A comparative study to establish the appropriate nutritional strategies to foster optimum growth and development in preterm infants. (ACE/98/18/SBS)

I am writing to inform you that the Advisory Committee on Ethics has considered the above protocol under its 'fast-track' procedure and has approved it on the understanding that the Ethics Guidelines are observed.

The Committee made one observation regarding the protocol, suggesting that all official letters must be written on hospital or University headed paper.

The Committee requires that the handling of blood must be carried out in accordance with the University Policy on the Donation and Use of Human Specimens in Teaching and Research (December 1995) and I enclose a copy of that Policy for your information. The Committee also requires that the Consent Form for the Donation of Blood conforms with that produced by the University and included in the attached policy document.

This letter of approval relates only to the study specified in your research protocol (ACE/98/18/SBS). The Committee should be notified of any changes to the proposal, any adverse reactions and if the study is terminated earlier than expected (with reasons). I enclose a copy of the Ethics Guidelines for your information.

Yours sincerely

Helen Schuylerman (Mrs)
Secretary, University Advisory Committee on Ethics

cc Dr Jacki Tredger, Principal investigator
    Dr Jane Morgan, Principal investigator
    Professor L J King, Chairman, ACE

Encs