

Animal milks in the diets of children aged 1-4 years

Key Points

- Breastmilk is the optimum main milk drink in the second year of life, but the majority of children aged 1-4 years in the UK have animal milk as their main milk drink from 1 year of age.
- As animal milk is widely consumed by young children in the UK it plays an important role in the provision of energy, macronutrients and micronutrients.
- Whilst a variety of animal milks could be used as the main milk drink for non-breastfed children, cows' milk remains the predominant choice in the UK. Liquid cows' milk currently provides a significant proportion of young childrens' fat, protein, calcium, magnesium, riboflavin and iodine intakes.
- Whole animal milk is recommended as the main milk drink for children from their first to second birthdays as it provides sufficient energy and a greater amount of the fat soluble vitamin, vitamin A than lower-fat milk.
- Because very high intakes of animal milk could contribute to low iron status and high protein intakes we suggest that families are advised that a maximum amount of 350mls of animal milk a day is adequate, particularly given most children eat other dairy foods.
- Dietary modelling is required to look at how diets with differing amounts of whole and semi-skimmed animal milks and other foods can best meet the nutritional requirements and food-based recommendations for children aged 1-4 years, whilst considering reducing the use of dairy foods to decrease greenhouse gas emissions.
- Given the central role cows' milk currently plays in the diets of young children it is important that the consequences of replacing cows' milk with plant-based milk alternatives are fully understood so that families can be advised how to meet dietary requirements adequately with other foods.

Introduction

There has been a long-term emphasis on the importance of animal milk in the diets of young children in many countries of the world. Milk is highly associated with early childhood in Western countries and has become the common replacement for breastmilk as the normal main drink for young children. The provision of free cows' milk to young children through welfare food schemes over many decades in the UK reflects the important role it has been given in supporting good nutrition, particularly of children in the poorest households.

Which animal milks are used for human consumption varies around the world depending on the climate and which animals thrive and are most commonly farmed. Given that the fundamental purpose of mammalian milk is to support the growth of mammalian offspring, its nutrient profile is uniquely and functionally aligned, combining proteins, fats, vitamins and minerals as well as non-nutritive components which protect the young from infection and promote physiological development and growth (Willett and Ludwig, 2020).

Because animal milks are commonly consumed and have been recommended by health workers for many decades, it is unsurprising that studies from countries where their intake is common show they are particularly important in terms of the energy and nutrient contribution they make to children's diets. Reviews of the diets of infants and young children (6-23 months) globally have concluded that where children's diets lack animal sourced foods such as milk, their nutritional requirements cannot be met without fortified products or supplements (WHO, 2005). In higher income countries where varied plant-based diets and supplementation can be provided, animal milk may not be a necessity. There is currently an ongoing review of the WHO complementary feeding guidelines which will be considering some of these issues and modelling different dietary patterns.

Unpicking the role of milk in the diets of young children in the UK remains difficult as the majority of young children are consumers. In this review we: share information on the composition of different animal milks; revisit current dietary guidelines for milk consumption by young children in the UK; outline the potential issues of lactose intolerance and cows' milk allergy; present data on milk consumption by 1-4 year olds; consider the nutritional contribution made by cows' milk, and suggest that current guidance on recommended milk volumes for 1-4 year olds may need review in light of the potential risks associated with large intakes. We end by considering how well aligned the dietary recommendations for animal milk consumption in young children are with dietary sustainability.

For information on alternative drinks to animal milk in the diets of 1-4 year olds see <https://www.firststepsnutrition.org/milks-marketed-for-children>.

The composition of different animal milks

The nutritional characteristics of milk from other animal species differ from cows' milk. These differences are seen particularly in protein content and profile (ratio and fractions of casein and whey), and fat content, as well as in some micronutrients. The main nutritional characteristics of selected mammalian milks are shown in Appendix 1. Animal milks vary in their composition, with energy contents of between 37-100kcal/100ml for the milks shown here, with human milk, cows' milk and goats' milk averaging 60-70kcal/100ml. Buffalo, sheep and camel milk have a higher energy content related to higher fat contents. There are some variations in vitamin and mineral contents of animal milks and some of these will be variable depending on how the animals are fed so giving average figures can be difficult. **However, from the age of 1 year all whole animal milks provide a suitable main milk drink providing that a good mixed diet is also consumed.** Where buffalo, sheep or camel milk is used as the main milk drink then advice should be given on volume consumed as these milks can add a significant amount of energy to the diet of young children.

What are the current dietary guidelines for milk consumption in young children in the UK?

Breastfeeding in the second year of life

Global health policy recommends breastfeeding for at least the first 2 years of a child's life (WHO, 2003). **The NHS advises that breastfeeding in the second year of life, alongside other complementary foods, is ideal** (NHS, 2021a). Whilst there is a critical lack of regular data collection tracking breastfeeding indicators beyond 6-8 weeks in the UK, breastfeeding rates are known to be among the lowest in Europe (RCPCH, 2021). Available data from the Infant Feeding Survey conducted in 2010 (McAndrew et al, 2012) and the Diet and Nutrition Survey of Infants and Young Children (DNSIYC) conducted in 2011 (Lennox et al, 2013), showed that while initiation of breastfeeding is high (78-81%), longer term breastfeeding is poor with the highest rates of attrition over the first 3 months of life. Of all infants 4-6 months old surveyed in the DNSIYC, 29% were consuming breastmilk at the time of the survey, decreasing to 8% of those aged 12-18 months. Of those children who had ever been breastfed, 57% were no longer receiving breastmilk at 3 months and 79% were no longer receiving breastmilk by the age of 6 months. Only 4% of those ever breastfed stopped receiving breastmilk between 12 and 18 months of age (Lennox et al, 2013).

There are limited studies which quantify the benefits of breastfeeding children over 1 year of age, but the available evidence indicates that breastfeeding in the second year continues to provide nutrition and immunological protection, is beneficial for IQ and subsequent achievement, provides some protection against overweight and obesity later in life, and offers emotional benefits for as long as it continues (Lopez et al, 2021; NHS, 2020; Grummer-Strawn et al, 2004). In addition, there is evidence that the act of breastfeeding over time confers protection against several non-communicable diseases in mothers, including breast cancer (Victora et al, 2016), ovarian cancer (Chowdhury et al, 2015), type II diabetes (Stuebe et al, 2005; Schwarz et al, 2010), rheumatoid arthritis (Karlson et al, 2004), hypertension, hyperlipidaemia and cardiovascular disease (Schwarz et al, 2009).

Introduction of animal milks as the main milk drink from 1 year of age

Whilst animal milk can be used in complementary food preparation for infants from 6 months of age, it is not recommended that animal milk becomes the main milk drink until 1 year of age when foods rather than milk make up the majority of the diet and provide the necessary iron. The rationale for encouraging continued milk consumption in young children is based on a combination of meeting energy needs (proportionally driven by the fat content), calcium requirements for bone deposition and the other nutrients that animal milk provides.

Most food-based dietary guidance recommends that:

- **From a child's first to second birthday, where children are not breastfed, whole animal milk can be the main milk drink.** Whole milk is more energy dense and carries more fat-soluble vitamins, particularly vitamin A, than lower-fat milks. Children may not get the energy or vitamins from lower-fat milk alternatives.
- **After 2 years of age semi-skimmed milk can be offered as the main milk drink instead of whole milk, provided a child eats well and is growing well for their age.** The fat content of milk does not significantly affect the water-soluble vitamin or mineral composition.
- Skimmed milk or 1% fat milk are not recommended as main milk drinks for children under 5 years of age as they do not contain enough energy.
- Drinks marketed as 'growing-up' and toddler milks are not needed by children over the age of 1 year. More information on drinks marketed as 'growing-up' and 'toddler milks' can be found here <https://www.firststepsnutrition.org/milks-marketed-for-children>.

Lactose intolerance and cows' milk allergy

Lactose intolerance

Lactose intolerance is largely genetically determined with an estimated prevalence of 5% in the UK population; most likely in those of Asian, African or South American descent. Lactose is the principal carbohydrate in all mammalian milks, including human milk, where it plays an essential role in the immune system by protecting the infant gut against pathogens. As such, lactose intolerance is uncommon in very young infants and children (Munblit et al, 2017) but prevalence increases with age. In 2011, EFSA noted a wide variation in the threshold for lactose-intolerant individuals and that individuals need to modify consumption to be compatible with their tolerance. However, some individuals can consume a single 'dose' or 12g of lactose (about 200mls of cows' milk) with no or minor symptoms (EFSA, 2011; Savaiano et al, 2006) and higher volumes may be tolerated when appropriately spaced over the course of the day. Given the nutritional risks associated with eliminating animal milk and milk products from the diets of young children who are not breastfed, spacing small volumes of milk throughout the day may be a suitable approach to ensure nutritional adequacy. Where lactose is poorly tolerated, the NHS recommends that lactose-free milk, some yoghurts and cheeses and soya or plant-based based drinks may be consumed, together with additional supplements of vitamin D and calcium (NHS, 2021c). Lactose-free milk contains an enzyme which breaks down any lactose contained within the product, but contains other nutrients in the same quantities as plain cows' milk.

Cows' milk allergy

Cows' milk can cause allergy in a small proportion of infants (estimated at about 1-3%) and young children, although 80-90% of children will acquire tolerance to cows' milk by the age of 6 years, where it affects less than 1% of children (Verduci et al, 2019). The current treatment for properly diagnosed cows' milk allergy is the elimination of cows' milk from the diet. Breastfeeding is

recommended and whilst current guidance in the UK is that there should be elimination of cows' milk products from the diet of breastfeeding mothers for babies with cows' milk allergy, this is not recommended everywhere (Verduci et al, 2019) and needs review. For information on suitable infant milks for infants diagnosed with cows' milk allergy see <https://infantmilkinfo.org/type-of-infant-milk/specialised-milks/specialised-milks-for-infants-with-allergies/>.

Current milk consumption patterns among 1-4 year olds in the UK

There is limited data on the dietary habits of children aged 1-4 years in the UK. Data from the National Diet and Nutrition Survey (NDNS) (combined data from 2008-2012; PHE, 2014) and the Dietary and Nutrition Survey of Infants and Young Children (DNSIYC) (Lennox et al, 2013) is presented in Table 1. Whilst more up to date data from the NDNS is available for some metrics, milk consumption data is only available in older survey tables and it is limited to breastmilk, cows' milk and formula milk.

Table 1: Milk consumption in children 12-36 months old in the UK

	12-18 months*		18-36 months**	
	% consumers	Mean intake g/day	% consumers	Mean intake g/day
Breastmilk	8	400 [†]	Data not available	
Cows' milk				
Whole Milk (3.8% fat)	79	329	64	280
Semi-skimmed Milk (1.8% fat)	13	169	43	192
1% fat milk			<1	214
Skimmed milk (0.5% fat)			4	335
Formula milk			Data not available	
Infant formula	1	389		
Hungry baby infant formula	1	350		
Follow on formula	16	323		
Growing-up/toddler milk	18	342		
Soya based infant formula	<1	373		
Other milk products	3	387		

* Lennox et al, 2013.

[†] Consumption estimated from stable isotope assessment

** PHE 2014.

How does animal milk contribute to the dietary intakes of children aged 1-4 years in the UK?

Successive nutritional surveys (NDNS 2008-2019) have consistently demonstrated an important role of milk and milk products in the nutrition of young children in the UK (PHE, 2020). **Milk and milk products are the main contributor to fat and protein intakes and are the second greatest contributor to energy intakes for children aged 18 months to 3 years. Liquid milk consumption provides almost a third of protein and fat in young children's diets and a quarter of energy intake.**

Milk and milk products were also shown to provide an average of 27% of total energy in children 12-18 months (Lennox et al, 2013). The contribution of milk and milk products to the energy intake of children 1.5-3 years has remained stable since the NDNS survey began, as has the relative contribution of whole milk and semi-skimmed milk. Whole milk was also reported to be the greatest single source of protein in the diets of children 12-18 months (18%) (Lennox et al, 2013) and for children 1.5-3 years (15%), see Table 2 (PHE, 2020).

Table 2. Comparison of milk versus other foods as a source of macronutrients for children aged 1.5-3 years*

Food group	Energy %	Protein %	Fat %	Carbohydrate %
Milk and milk products	24	31	32	16
- of which whole milk	11	15	17	6
- of which semi-skimmed milk	2	5	3	2
Cereal and cereal products	33	25	21	45
Meat and meat products, fish and fish products, eggs and egg dishes and fat spreads.	18	31	28	5
Vegetables and potatoes, savoury snacks, nuts and seeds	11	8	10	12
Fruit, sugar and preserves, confectionery	6	2	1	7
Sugar preserves and confectionery, beverages and other miscellaneous foods.	9	4	7	10

*PHE, 2020

The contribution of liquid milk to the intakes of some micronutrients in the diets of children aged 1.5-3 years are shown in Table 3. **Liquid milk provides a significant amount of a number of micronutrients to the diets of young children in the UK. A fifth of vitamin A, zinc and**

potassium, nearly 40% of riboflavin, calcium and magnesium intakes and nearly 50% of iodine intakes are provided by liquid milk.

Requirements for calcium are high in children aged 1-4 years; 350mg/day for 1-3 year olds rising to 450mg/day for 4 year olds (PHE, 2016). Calcium is needed for building and maintaining healthy bones, for the transmission of nerve impulses and muscle actions and for many other body functions. Animal milk is one of the richest sources of calcium and the calcium from dairy products is well absorbed (Bałowska et al, 2011; Scholz-Ahrens et al, 2019). NDNS data shows that young children in the UK have a mean consumption of 200% of the reference nutrient intake: 790mg/day for children aged 12-18 months (Lennox et al, 2013) and 707mg/day for children aged between 1.5 and 3 years; of which 254mg came from liquid milk, which is 73% of the dietary reference nutrient intake for this age group.

Table 3. Comparison of milk versus other foods as a source of micronutrients for children aged 1.5-3 years*

Food group	Vitamin A	Riboflavin	Vitamin D	Calcium	Magnesium	Potassium	Zinc	Iodine
Milk and milk products	35	54	30	59	25	30	35	64
- of which whole milk	16	28	-	27	13	16	15	34
- of which semi skimmed milk	3	10	-	9	4	5	5	13
Cereal and cereal products	11	22	24	24	29	16	26	10
Meat and meat products, fish and fish dishes, eggs and egg dishes, fat so	19	11	41	6	12	13	23	16
Vegetables and potatoes	22	3	1	3	12	16	7	2
Sugar preserves and confectionery, beverages	4	3	0	3	5	5	1	2

*PHE, 2020. All data are from food sources only

Iodine is essential for the production of the hormone thyroxine, which affects the function of the thyroid gland. It is used to regulate the body's metabolism, and affects the heart rate, body temperature and how the body uses energy from food. It is also important for brain development.

Children aged 1.5-3 years need about 70 micrograms a day, rising to 100 micrograms in children aged 4 years. Children in the UK obtain almost 50% of their iodine intake from liquid milk and this meets 85% of the reference nutrient intake. About 4% of children aged 1.5-3 years fall below the lower reference nutrient intake, rising to 7% of children aged 4-10 years (PHE, 2020).

Zinc plays a major role in the functioning of every organ in the body. It is needed for the normal metabolism of protein, fat and carbohydrate and is associated with the hormone insulin, which regulates the body's energy. Zinc is also involved in the immune system, the utilisation of vitamin A, and in wound healing. Children aged between 1 and 3 years have a reference nutrient intake of 5mg of zinc per day, rising to 6.5mg at the age of 4 years. Mean intake for children in all age groups is slightly below the reference nutrient intake with 8% of children aged 1.5-3 years having intakes below the lower reference nutrient intake. Liquid milk provides a fifth of total intakes of zinc to the diets of 1.5-3 year olds.

Vitamin A plays an essential role in the immune system, vision, growth and bone development and as such is a vital micronutrient in the diets of young children. It can be obtained from the diet in two ways; as pre-formed retinol found in animal-sourced foods, and as carotenoids, a precursor to vitamin A, found in plants. Absorption of fat-soluble vitamins is enhanced by dietary fat, so pre-formed retinol derived from whole milk is absorbed most efficiently. Children aged 1-4 years in the UK have a reference nutrient intake of 400 micrograms of vitamin A per day. Liquid milk provides 19% of vitamin A in the diets of children aged 1.5-3 years. Semi-skimmed milk is about 46% lower in vitamin A than whole milk. The mean intake of vitamin A in children 1.5-3 years is slightly above the reference nutrient intake at 460 micrograms per day, although 9% of children in this age group fall below the lower reference nutrient intake, rising to 11% of children aged 4-10 years. Current recommendations that all children aged 1-4 years should have daily vitamin drops containing vitamin A acts as a safety net for those children who may have low intakes of dairy products and fruit and vegetables.

The nutritional profile of whole cows' milk compared with lower-fat cows' milks

Reducing the fat in milk also reduces the amount of energy contained, and, because fat is a carrier of fat soluble vitamins, reducing the fat content also reduces the amount of vitamin A provided, see Table 4. Water soluble vitamin content and the mineral content of milks stays the same regardless of fat content.

Table 4: A comparison of the nutritional composition of whole, semi-skimmed, 1% fat and skimmed cows' milk*

Per 100mls	Whole cows' milk	Semi-skimmed cows' milk	1% fat cows' milk	Skimmed cows' milk
Energy kcal/day	63	46	41	34
Total Protein(g)	3.4	3.5	3.5	3.5
Total Fat (g)	3.6	1.7	1.0	0.3
Saturated fatty acids (g)	2.3	1.1	0.6	0.1
Monounsaturated fatty acids (g)	1.0	0.4	0.2	0.1
Polyunsaturated fatty acids (g)	0.1	Tr	0.2	Tr
Carbohydrate as lactose (g)	4.6	4.7	4.8	4.8
Vitamins				
Vitamin A (µg retinol equivalents)	38	21	9	1
Vitamin E (mg)	0.06	0.04	0.02	Tr
Thiamin (mg)	0.03	0.03	0.03	0.03
Riboflavin (mg)	0.23	0.24	0.23	0.22
Niacin (mg)	0.2	0.1	0.1	0.1
Pantothenic Acid (mg)	0.58	0.68	0.59	0.50
Vitamin B6 (mg)	0.06	0.06	0.06	0.06
Folate (µg)	8	9	9	9
Biotin (µg)	2.5	3.0	2.8	2.5
Vitamin B12 (µg)	0.9	0.9	0.9	0.08
Vitamin C (mg)	2	2	2	1
Vitamin D(µg)	Tr	Tr	Tr	Tr
Minerals				
Sodium (mg)	42	43	44	44
Iron (mg)	0.02	0.02	Tr	0.03
Calcium (mg)	120	120	123	125
Magnesium (mg)	11	11	11	11
Phosphorous(mg)	96	94	95	96
Potassium (mg)	157	156	159	162
Zinc (mg)	0.5	0.4	0.5	0.5
Iodine (µg)	31	30	30	30

*Finglas et al, 2015

Volume of milk recommended for 1-4 year olds

The NHS recommends that young children are given *at least* 350mls of milk a day, or 2 servings of foods made from milk such as cheese, yoghurt or fromage frais (NHS, 2021b). **As most children also consume dairy products other than liquid milk, we believe that 350mls/day is unlikely to be needed as a minimum, and it could be seen as a maximum amount.**

Based on current guidelines and consumption patterns, 350mls of whole cows' milk per day for children in the second year of life, and 350mls of semi-skimmed milk per day for children aged from their 2nd to 5th birthday provides over 100% of their calcium, riboflavin and iodine requirements, between 71 and 82% of the protein needed and about a third of zinc requirements (see Table 5). Whole milk provides about a third of the vitamin A needs of children in the second year of life and semi-skimmed milk provides just under 20% of requirements for 3-5 year olds.

Table 5: Amount of energy and nutrients provided by 350mls of whole cows' milk or semi-skimmed cows' milk to children of different ages

Energy or nutrient	350mls of whole milk provides	% of EAR/DRV met by 350mls of whole milk for children from 1 st to 2 nd birthday	350mls of semi-skimmed milk provides	% of EAR/DRV met by 350mls of semi-skimmed milk for children from 2 nd to 5 th birthday
Energy (kcal)	221	30	161	14
Protein (g)	11.9	82	12.3	72
Fat (g)	12.6	44	6.0	28
Vitamin A (µg)	133	33	74	17
Riboflavin (mg)	0.8	133	0.8	123
Calcium (mg)	420	120	420	112
Zinc (mg)	1.8	36	1.4	33
Iodine (µg)	109	156	105	135

EAR Estimated Average Requirement

DRV Dietary Reference Value

Values have been calculated for the age groups proportionally from data provided by SACN, 2011 and DoH, 1991

The use of semi-skimmed milk for children in the second year of life would reduce the amount of energy, fat and vitamin A provided but would still offer significant amounts of protein, riboflavin, calcium, zinc and iodine.

Are there any nutritional risks associated with animal milk consumption?

High protein intakes

Protein is needed for growth and for maintaining and repairing body tissues, and to make the enzymes that control many body functions. However, it has been suggested that excess protein consumption, particularly in the first two years of life, may lead to rapid weight gain and the development of overweight and obesity in early childhood (Günther et al 2007; Koletzko et al, 2016; Pimpin et al, 2016). Pimpin et al (2016) found evidence of increased body mass index and weight up to 36 months of age among children with protein intakes in excess of 15% daily total energy, and in children up to 60 months of age who consumed in excess of 16.2% of their daily energy from protein, although these findings lacked statistical significance. And while some studies have linked the higher protein content in cows' milk-based infant formula to adiposity and

rapid weight gain (Arenz et al, 2005; Tang, 2018) the effect of protein from sources other than formula, including dairy proteins, are not yet clear (Tang, 2018). Given the available data, the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition recommend limiting protein intake to 15% of total energy for infants and toddlers (Agostoni et al, 2008) as intakes far above the requirements have no known benefit but may carry a risk. Consumption of 350mls of whole cows' milk in the diets of children in the second year of life would provide 6.4% of total energy from protein, and for children from their 2nd to 5th birthday 350mls of semi-skimmed milk would provide 4.3% of total energy from protein.

More research is needed to identify plausible mechanisms by which excess protein increases the risk of overweight and obesity, to identify or distinguish protein sources that contribute risk and to evaluate effect sizes based on protein intake thresholds. Modelling of diets for children aged 1-4 years would also allow different dietary patterns and different volumes of milk within these to be explored to provide evidence for dietary guidance on milk consumption.

Iron deficiency

Iron is essential for the function of several body systems and particularly for haemoglobin which carries oxygen in the red blood cells. A deficiency in iron can cause anaemia. Iron deficiency means that the blood transports less oxygen for the body's needs and so limits the person's ability to be physically active. Children with iron deficiency will be pale and tired and their general health, resistance to infection, appetite and vitality will be impaired. Sometimes there are no apparent symptoms, and iron deficiency may be undetected. Prevention of iron deficiency is important because, apart from the immediate effects listed above, it has an immediate and longer-term impact on childrens' intellectual performance and behaviour (Umbreit, 2015). However, too much iron can also be harmful, affecting growth, illness and development (Lönnerdal, 2017), and it is better to get iron from food sources rather than from supplements, unless iron deficiency has been diagnosed and is being treated.

Very young children are at particular risk of low iron status as a result of rapid growth and consequential high iron requirements (ESPGHAN, 2017). From the National Diet and Nutrition Survey data 2012-2014 (PHE, 2016), 5% of children aged 1.5-3 years had low haemoglobin levels, but 31% had low plasma ferritin levels. Children in this age group consume 19% less iron on a daily basis than dietary guidelines recommend and 11% of children in this age group have intakes that fall below the lower reference nutrient intake. This suggests that a proportion of children aged under 5 years in the UK may have both low iron intakes and low iron status, and figures from the NDNS may underestimate this as the sample size is small and children living in greater deprivation may be under-represented.

Animal milk is a poor source of iron and it is for this reason that dietary guidelines advise against the introduction of cows' milk into the diets of children before the age of 12 months. In the UK, children obtain the vast majority of dietary iron from cereal and cereal products, followed by meat and vegetables. However, high animal milk consumption (and bottle use) has been associated

with poorer appetites for solid food in young children (Lawson et al, 1998; Ziegler, 2011) and the displacement of richer dietary sources of iron. In the study by Lawson et al, 2 year old children were consuming about 500-600mls of animal milk a day and this was significantly associated with poor iron status. **Care needs to be taken when recommending animal milk as the main milk drink that families are aware of the portion size recommended and the risks of large volumes of milk, particularly when given in a bottle (from which larger volumes are likely to be consumed) to a child over 1 year of age.**

How well aligned are the dietary recommendations for animal milk consumption in young children with dietary sustainability?

Food systems undoubtedly have an adverse impact on the environment, including depleting natural resources and biodiversity and polluting the air, water and soil; but it is their impact on climate change-induced by greenhouse gas emissions that has received the greatest attention. It has been estimated that in the UK, greenhouse gases associated with both food produced domestically and food imported for UK consumption represent around 19% of the total (Garnett, 2011). Of this, around 8% is attributable to the growing of food by the agricultural sector, and the majority of the balance is accounted for by food and fertiliser manufacturing, transport, packaging, refrigeration and waste disposal. Within the agricultural sector, livestock production for meat and dairy foods is estimated to account for 80% of agricultural greenhouse gas emissions (McMichael et al, 2007). Audsley et al (2009) suggest that very significant changes in the food system would be required to achieve a 70% reduction across the supply chain in order to meet the UK Climate Change Act, but that UK diets might not have to alter substantially if agriculture became significantly more efficient.

There is some agreement that achieving a fundamental shift towards a diet that is lower in animal-based foods and higher in plant-based foods might contribute to the mitigation of food-related greenhouse gases. But whilst the main principles of a healthy diet are the same for children and adults, food-based dietary guidelines for children cannot simply be extrapolated from those for adults, as the nutritional demands of growth and development mean that, in proportion to their body size, children need different proportions of certain nutrients. In particular, children derive proportionally more of their nutrients from milk and milk products and proportionally less of their nutrients from meat and meat products than adults.

There is little doubt that consuming more plant-based foods is beneficial for health of adults and children alike, and aligns well with the general messages surrounding achieving more sustainable consumption. But when considering the impact of reductions in meat and dairy products, it is essential that children's diets are considered separately from those of adults. For more information see the report *Healthy and Sustainable Diets in the Early Years* at www.firststepsnutrition.org/reports.

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Appendix 1

A comparison of the nutritional composition of selected mammalian milks

Per 100ml	Human breastmilk ^a	Cow ^b	Buffalo ^b	Goat ^b	Sheep ^b	Donkey ^b	Mare ^b	Camel ^b
Energy kcal	69	62	99	66	100	37	48	76
Total Protein(g)	1.3	3.3	4.0	3.4	5.6	1.6	2.0	3.9
Casein (range g/100g)	0.3-0.4 ^d	2.5-2.8 ^f	4.0 ^f	2.8 ^g	4.2 ^e	0.6-1.0 ^d	0.9-1.0 ^d	2.2 ^h
Whey (range g/100g)	0.7-0.8 ^d	0.6-0.7 ^d			1.0 ^e	0.5-0.8 ^d	0.7-0.9 ^d	
Total Fat (g)	4.1	3.3	7.5	3.9	6.4	0.7	1.6	5
Saturated fatty acids (%) ^c	46.6	67.7	65.9	70.4	65.2	67.6	47.4	51.9
Polyunsaturated fatty acids (%) ^c	9.9	5.3	2.7	4.1	2.5	16.6	22.0	8.5
Carbohydrate as lactose (g)	7.2	4.7	4.4	4.4	5.1	6.4	6.6	4.2
Vitamin A (µg retinol equivalents)	58	37	69	48	64			97
Thiamin (mg)	0.02	0.04	0.05	0.06	0.07	0.03	0.06	0.01
Riboflavin (mg)	0.03	0.2	0.11	0.13	0.34	0.03	0.02	0.12
Niacin (mg)	0.2	0.13	0.17	0.24	0.41	0.09	0.07	
Vitamin B6 (mg)	0.01	0.04	0.33	0.05	0.07			0.05
Folate (µg)	8.5	8.5	0.6	1.0	6.0			
Vitamin B12 (µg)	0.04-0.06	0.5	0.4	0.07	0.66			
Vitamin C (mg)	4.0	1.0	2.5	1.1	4.6		4.3	3
Vitamin D(µg)	*	0.2		0.1	0.2			1.6
Iron (mg)	0.07	0.1	0.2	0.3	0.1		0.1	
Calcium (mg)	34	112	191	118	190	91	95	154
Magnesium (mg)	3	11	12	14	18	4	7	8
Phosphorous(mg)	15	91	185	100	144	61	58	132
Potassium (mg)	58	145	112	202	148	50	51	186
Zinc (mg)	0.3	0.4	0.5	0.3	0.6		0.2	0.7
Iodine (µg)	7	32						

a First Steps Nutrition Trust, 2020

b FAO, 2013

c Nayak, Ramachandra and Kumar, 2020

d Guo et al, 2007

e Dario et al, 2008

f Zicarelli 2004

g Leitner et al, 2004

h Khaskeli et al, 2005

*Vitamin D in human milk varies considerably and there is little consistency between studies.

The data for cows' milk composition shown here is taken from FAO data and there are small variations between this data and that from the UK Food Tables shown in Table 4.