Why breast milk matters

Abstract

Midwives understand the benefits of breastfeeding, both for the infant and mother. However, the biochemical and physiological reasons for the superiority of breast milk are less widely known. This is, in part, because of the extraordinary complexity of breast milk's composition. Its key components include nucleotides, which benefit gut and immune development, human milk oligosaccharides, which promote an optimal gut biome, lipids in the milk fat globule membrane, which promote gut health and brain development, immunoglobulins, which modulate the infant's immune system, and an optimum protein content, which is high in the first 2 weeks after birth but decreases thereafter. A greater awareness and understanding of the mechanisms behind the benefits of breastfeeding could help midwives to have informed discussions with parents and potentially contribute to improving the UK's breastfeeding rates. Growing understanding of breast milk's unique composition may also help infant formula manufacturers drive innovation and improve the formulation of their products.

Keywords

Formula feeding | Human milk composition | Infant feeding

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Midwives are trained to offer all new mothers support in making informed choices on how to feed their baby. This support is based on robust evidence that breastfeeding offers the most complete form of nutrition during the first 6 months of life. Expert opinions from the World Health Organization (2023) to the public health bodies responsible for England, Scotland and Wales recommend exclusive breastfeeding for the first 6 months of life and that breastfeeding should continue for at least the first year (The Scientific Advisory Committee on Nutrition, 2018; Welsh Government, 2019; Public Health Scotland, 2020).

However, in the UK, breastfeeding rates fall short of this ideal. Current data suggest that around 72% of babies born in the UK are breastfed within 48 hours of birth, but only 1% are exclusively breastfed until 6 months (McAndrew and Thompson, 2012; Nuffield Trust, 2022). This low breastfeeding initiation and high drop off rate is despite 30 years of best practice guidance, as advised by UNICEF's (2013) baby friendly initiative, introduced to the UK's health services in 1994. There is evidence that the initiative has increased very early breastfeeding rates in the UK (birth to 7 days), but this increase is not sustained at 1 month (Fallon et al, 2019). Thus, current breastfeeding rates fall short of the recommendations.

The baby friendly initiative stresses the importance of discussing the health advantages of breastfeeding with all parents, so that they can make informed choices on how to feed their child. It also emphasises that parents should receive appropriate support for whichever method of feeding they choose. Healthcare professionals, including midwives, health visitors, breastfeeding support workers and early years professionals, play a major role in supporting mothers to breastfeed. For example, a Cochrane systematic review found that providing women with extra organised support helped mothers breastfeed their babies for longer (Gavine et al, 2022). Most healthcare professionals are well equipped to do this and have a robust appreciation of the nutritional and psychological benefits of breastfeeding. But the

biochemical and physiological mechanisms that underpin the superiority that breast milk holds over infant formula milk are less well understood.

Several recent studies have sought to address this knowledge gap (Victora et al, 2016). There is now growing comprehension of what it is about breast milk that delivers such extraordinary health benefits. This knowledge may be of particular interest to midwives, who can use the information to advise parents on the benefits of breastfeeding and offer more comprehensive guidance to parents who decide, at some point, to use infant formula milk.

The benefits of breastfeeding

The most recent comprehensive review of breastfeeding was published in the Lancet in 2016 by Victora et al (2016). This included 28 systematic reviews and meta-analyses from low-, middle- and high-income nations, and emphasised the importance of breastfeeding 'for all women and children, irrespective of where they live and whether they are rich or poor' (Victora et al, 2016).

Benefits of breastfeeding for the infant

Short term benefits:

The short-term benefits of breastfeeding for the infant include (Bowatte et al, 2015; Victora et al, 2016):

- Preventing diarrhoea: breastfeeding can reduce the incidence of diarrhoea by up to 50%, and hospitalisation for diarrhoea by 72% in low- to middle-income countries
- Reducing the incidence of necrotising enterocolitis: this devastating condition in newborns has a high fatality rate in sick and premature babies; breastfeeding can reduce its incidence by 58%
- Reducing the risk of sudden infant death syndrome: in high-income countries, breastfeeding can reduce the risk of sudden infant death syndrome by more than a third
- Reducing the rate of otitis media: exclusive breastfeeding is associated with a 43% reduction in otitis media in the first 2 years of life.

Long-term benefits

The long-term benefits of breastfeeding for the infant include:

- Protection against overweight and obesity in later life: a 13% reduction in the prevalence of child overweight or obesity has been reported in those who were breastfed as infants (Victora et al, 2016)
- Cognitive function: breastfeeding is positively linked to higher performance scores in a range of intelligence tests throughout childhood and adolescence (The Scientific Advisory Committee on Nutrition, 2018)
- Reducing the rate of childhood infections: exclusively breastfeeding at 1 week until 4 months could reduce the incidence of gastrointestinal illness, lower respiratory tract infection and acute otitis media (Pokhrel et al, 2015)
- Lower rates of asthma: breastfed infants have lower rates of asthma than those given formula feeds (Grummer-Strawn and Rollins, 2015).

Benefits of breastfeeding for the mother

Mothers also benefit from breastfeeding their infants. These benefits include:

- Reducing risk of breast cancer: a mother's risk of breast cancer reduces by 4.3% for every 12 months of lifetime breastfeeding (Victora et al, 2016)
- Reducing risk of ovarian cancer: longer breastfeeding is associated with a 30% reduction risk of ovarian cancer (Victora et al, 2016); the risk of ovarian cancer decreases by 8% for every 5-month increase in the duration of breastfeeding (Luan et al, 2013)
- Protection against type II diabetes: breastfeeding may offer some protection against developing diabetes (Grummer-Strawn and Rollins, 2015)
- Postnatal depression: there is a clear link between breastfeeding and reduced postnatal depression (Victora et al, 2016)
- Behavioural benefits: these go beyond the nutritional content of breast milk and include encouraging maternal responsive behaviours; recognising when infant behaviours are cues for hunger and satiety or for comfort and reassurance (Ventura, 2017).

The composition of breast milk

The remarkable health benefits of breast milk derive from its unique composition. Breast milk is not only a source of nutrients, it is a living biological fluid that contains over 300 components that are currently known. Breast milk consists of around 87% water, 7% lactose (sugar), 3.8% fat and 1% protein (Martin et al, 2016). Together the fat and lactose provide around 90% of breast milk's energy content. Despite the best efforts of formula manufacturers, no artificial feed (which contain 75 components at most) has ever come close to mimicking breast milk's complexity.

The composition of breast milk is not static. It changes over time, both during a single feed and over the nursing period, to adapt to the changing needs of a growing infant. For instance, milk expressed early in a feed is higher in lactose than later-expressed milk, which is higher in fat. The protein content of breast milk is higher during early infancy than in the later stages of infancy (Martin et al, 2016).

The fatty acid content of breast milk is particularly important in the first few weeks after birth, when a

newborn is rapidly synthesising brain tissue. The enzymes required to synthesise the essential fatty acids arachidonic acid and docosahexaenoic acid are not yet fully functional in the first few weeks of life, thus these fatty acids must be provided during feeding. Docosahexaenoic acid is critical for visual acuity, neural function and development (European Food Safety Authority, 2014).

The most prevalent fatty acid in breast milk is palmitic acid. Around 70% of palmitic acid is present in fats (triglycerides) in an unusual esterified form known as SN-2. This is different to the structure of fats contained in infant formula. The SN-2 structure seems to confer particular benefits in terms of softer stools, promotion of bone health and better diversity in gut flora (Bronsky et al, 2019).

While the composition of breast milk does change in response to a mother's diet, it remains remarkably resilient in its ability to nurture an infant. Even if a mother's own nutrition is relatively poor, her breast milk is likely to contain all the essential nutrients, vitamins, minerals, digestive enzymes and hormones necessary to support her growing infant (Martin et al, 2016). It will also contain a range of bioactive components that can protect against pathogens, promote immune development and play a vital role in colonising the infant gut with a diverse and balanced microbiota (Vandenplas et al, 2020). The changing composition of breast milk also contributes to the development of diverse and healthier taste preferences (Mennella et al, 2017).

Human milk oligosaccharides

Among the bioactive components of breast milk, the human milk oligosaccharides are key, and make up the third most abundant solid component of breast milk, after lactose and lipids (Wiciński et al, 2020). Over 160 varieties of these indigestible sugars have been identified, and they are known to have anti-adhesive properties for pathogens in the gut, play a role in modulating the immune system, promote the growth of healthy bacteria, such as bifidobacteria and lactobacilli, and interact beneficially with viruses, bacteria and protozoa (Wiciński et al, 2020).

Nucleotides

Breast milk also contains nucleotides, which are bioactive compounds with important cellular and metabolic functions for the infant (Hodgkinson et al, 2022). They form the basis of DNA and RNA, are essential for rapidly dividing tissues, such as the intestinal epithelium, promote intestinal flora and stimulate immune function (Cosgrove, 1998).

Milk fat globule membrane

Another unique component of breast milk is a complex three-membrane structure known as the milk fat globule membrane. This contains a plethora of proteins, cholesterol and phospholipids that are thought to aid in infant brain development and immune function (Hernell et al, 2019).

Immunoglobulins

Immunoglobulins in breast milk are crucial in shaping and modulating an immature infant's immune system and providing efficient protection against pathogens (Czosnykowska-Łukacka et al, 2020).

Formula feeding

Despite universal consensus for the promotion and encouragement of exclusive breastfeeding over the past 30 years, most parents in the UK initiate some degree of formula feeding before their child reaches 6 months of age (McAndrew and Thompson, 2012). Nearly three in four (73%) mothers give their baby infant formula milk by the age of 6 weeks, and 88% by 6 months (McAndrew and Thompson, 2012; Nuffield Trust, 2022). Therefore, it is important that infant formula manufacturers respond to recent advances in understanding of the mechanisms behind the benefits of breastfeeding.

In the authors' opinion, there will never be an infant formula that can truly mimic the health benefits of breast milk. Nevertheless, although there are relatively few independent studies and most trials have been conducted or supported by formula manufacturers, a number of innovations in formula composition have been made over the years that may start to narrow the gap.

Nucleotides

Nucleotides were first added to formula in the 1960s, in order to mimic the levels in breast milk. However, there is inconsistent evidence to suggest that the addition of nucleotides to infant formula has a beneficial effect on an infant's immune function, gut and microbiome development and growth (Yu, 1998; Wang, 2019).

SN-2 palmitate

SN-2 palmitate is added to formula milk to mimic the fat content of human milk. This has been used since 1996 and was shown to improve infants' growth and bone mineralisation, reduce faecal calcium soaps (a cause of hard stools) and induce healthy changes in the gut microbiome in a meta-analysis (Zhang et al, 2022).

Galactooligosaccharides and fructoolicosaccharides

The probiotics galactooligosaccharides and fructoolicosaccharides have been added to some infant formulas since 2004, to mimic the effect of human milk oligosaccharides that are not found in the cow's milk

on which formula feeds are based. Studies suggest that the addition of these probiotics offers benefits such as improved immunity and bowel function (Vandenplas et al, 2015).

Milk fat globule membrane

Adding milk fat globule membrane from cow's milk can mimic the benefits of milk fat globule membrane found in human milk. Although cow's milk does contain milk fat globule membrane, these lipid structures are destroyed in the pasteurisation process. So, until recently, formula milk did not contain milk fat globule membrane. However, microfiltration and supercritical fluid extraction methods have made it possible to isolate milk fat globule membrane from unpasteurised cow's milk and preserve it for use as an additive in infant formula. Research suggests that this addition may be linked to long-term cognitive benefits in children at 6 years old (Nieto-Ruiz et al, 2022).

A novel concept involves adding large phospholipid-coated lipid droplets into formula milk. This mimics the lipid structure found in human milk and supports adequate infant growth (Teoh et al, 2022).

Protein

Reducing the protein content of infant formulas to better match the composition of human breast milk is also a recent innovation. Lower protein formulas (that result in slower infant weight gain) have been shown to reduce the risk of obesity in later life (Singhal, 2018).

Conclusions

Breast milk is a unique, living, biological fluid with a range of health benefits that extend far beyond its nutritional content. Different constituents in human milk individually or synergistically promote health outcomes in the infant as diverse as respiratory health, immune development, gut health and cognition. Breastfeeding also benefits mothers in terms of their physical and mental health. Knowledge of the biochemical and physiological mechanisms behind these benefits is continually growing and may help midwives offer evidence-based support to all parents, whatever their preferred method of feeding their infant. This knowledge should also be used by infant formula manufacturers to drive innovation to ensure their products come as close as possible to providing the health benefits of human breast milk. **BJM**

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Key points

- Public health guidance recommends that exclusive breastfeeding should continue for around the first 6 months of life.
- The remarkable health benefits of breast milk derive from its unique composition, which includes over 300 different components.
- Breast milk composition changes over feed time and overall lactation period to meet the needs of the growing infant.
- In addition to nutrients, breast milk also contains a range of bioactive components that can protect against pathogens, promote immune development and help colonise the infant gut with a diverse and balanced gut bacteria.
- Innovations in the manufacture of infant formula feeds have sought to mimic the actions of a number of these bioactive components.

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CPD reflective questions

- How close is the UK to reaching the breastfeeding recommendations set by the World Health Organization?
- What are the health benefits of breastfeeding to mothers and infants?
- What is it about breast milk that means it is able to deliver such diverse health benefits?
- How close are infant formulas to mimicking the health benefits of human breast milk?

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