

# The nutritional needs of moderate–late preterm infants

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## Abstract

This article discusses the nutritional needs of moderate and late preterm infants (born between 32+0 weeks and 36+6 weeks' gestation) and makes recommendations for best practice both while these infants are in hospital and when they are discharged into the community. These recommendations were derived following a roundtable meeting of a group comprising two neonatologists, three paediatric dietitians, a health visitor/ paediatric nurse and a midwife practitioner. The meeting and medical writing assistance was sponsored by Nutricia. None of the participants accepted honoraria for their contributions to the discussion.

**Key words:** Breastfeeding; Breast milk; Late preterm infants; Moderate preterm infants

## Introduction

According to the Office of National Statistics (2020), preterm births in England and Wales in the last decade were 7–8% of all live births. The majority of these occur at 32–36 weeks of gestation, which is the age range covered in this article. Similar figures are seen in Scotland (Information Services Division, 2019). While recommendations exist for the nutritional requirements of very preterm infants, particularly those born below 1800 g (Agostoni et al, 2010), the nutritional requirements of moderate and late preterm infants to optimise their growth and development are less well established (Lapillonne et al, 2013, 2019; Brown et al, 2014; Muelbert et al, 2019).

## Challenges in current practice

An important first challenge is to establish how this group of infants is defined. The European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN), the US National Institute of Child Health and Human Development and the World Health Organisation (WHO) subdivide the moderate–late preterm period based on gestational age. Specifically, infants born between 34+0 weeks and 36+6 weeks are defined as 'late preterm' and, commonly, those born between 32+0 weeks and 33+6 weeks are defined as 'moderately preterm' (Lapillonne et al, 2019).

Important biochemical and structural changes continue to take place in the fetal brain and body throughout the third trimester of pregnancy. This is also a critical time for accumulating stores of energy and nutrients that the infant will draw on in the perinatal period (Lapillonne et al, 2013; Brown et al, 2014). Infants born before the end of the third trimester are deprived of some of these nutrients and also an important period of development. This can lead to higher rates of mortality, morbidity and hospital readmission in the neonatal period compared to full-term infants; poorer growth rates and intellectual development, and a higher risk of metabolic and cardiovascular disease in later life are also potential complications for these infants (Lapillonne et al, 2013; Brown et al, 2014; Simeoni et al, 2018; Muelbert et al, 2019; Centers for Disease Control and Prevention, 2021), although studies so far are observational. In addition, full oromotor maturity does not develop until approaching term, meaning that late preterm infants are at risk of poor growth because of their inability to take in sufficient milk for their nutritional needs. These infants are sometimes mistakenly thought to be more mature than they actually are with regard to feeding because of their relatively good weight, sometimes being referred to as 'the great pretenders'. Progress is best made using an approach based on an infant's cues of feeding readiness (White and Parnell, 2013; Lubbe, 2018).

Maternity hospitals in the UK have clear protocols for the care of infants born at or before 32 weeks' gestational age. There is less clarity for moderate and late preterm infants, and

### How to cite this article:

Johnson MJ, King C, Boddy B, Craig S, Males J, McEwan T, Tagani S. The nutritional needs of moderate–late preterm infants. *Br J Hosp Med.* 2022. <https://doi.org/10.12968/hmed.2022.0148>

often variation between hospitals in terms of where these infants are cared for and who provides this care (postnatal wards vs transitional care vs neonatal units). Those born at 32–34 weeks' gestational age are usually admitted to the neonatal unit where they receive care from neonatologists or paediatricians and a specialist healthcare team until they are ready for discharge, usually as they approach 37 weeks' corrected gestational age. Infants born after 34 weeks may be cared for on transitional care or postnatal wards, where their needs will be assessed and monitored predominantly by the midwifery team with varying input from the neonatal or paediatric team.

A challenge with establishing breastfeeding in moderate preterm infants is that they can often be jaundiced (which can make them sleepy) and still have an immature sleep–wake pattern so are asleep for longer periods than term infants. Owing to their immature oromotor function they also struggle to attach to the breast and drain it effectively. When milk removal is less than optimal for that infant their growth begins to falter and milk production is reduced (Walker, 2008). This occurs as a result of the feedback control nature of breast milk production, with a reduction in milk removal causing the breast to produce less milk, which can lead to a spiralling downwards of milk production and in turn suboptimal weight gain in the infant. Lactation support is needed to overcome the risk of a mother's milk supply dwindling in these circumstances, so she continues to express her milk to keep her supply up ready for when her infant is mature enough to take the milk volume required. These infants may be discharged from hospital exclusively breastfeeding, be breastfeeding and receiving breast milk fortifier, receiving breast milk plus formula top ups or fed exclusively with formula. The challenge is then to regularly monitor their growth and development so that growth faltering can be identified and interventions made.

Late preterm infants may be discharged home without being assessed for additional nutritional support if they appear to be feeding well. While this is reasonable, it can be challenging for several reasons. First, experienced and trained practitioners are best at assessing whether an infant is feeding well at the breast, and a less experienced person may not identify feeding problems. However, there is useful guidance published by the UNICEF Baby Friendly Initiative which includes many signs of good milk transfer in addition to the commonly used approach of assessing the pattern of stooling and urine production (<https://www.unicef.org.uk/babyfriendly/baby-friendly-resources/implementing-standards-resources/breastfeeding-assessment-tools/>). Second, infants who have been thought to be feeding well and not in need of support are often discharged without any communication between hospital and community staff regarding the potential for growth faltering or nutritional intervention, and without a plan on how to improve nutrition and support feeding if there is a problem.

## Identifying poor nutrition

One clear sign that an infant is not receiving the nutrition it needs is a failure to put on adequate amounts of weight. Most infants lose weight in the first few days of life, as part of the normal diuresis and natriuresis that occurs after birth, returning to their birth weight by 3 weeks of age (National Institute for Health and Care Excellence, 2017). The National Institute for Health and Care Excellence (2017) recommends that infants who lose more than 10% of their birth weight in the perinatal period, or who have not returned to their birth weight by 3 weeks, should be clinically assessed, including feeding habits, and feeding support provided if required.

Regular weighing of infants with excessive early weight loss ( $\geq 10\%$  of birth weight) is recommended (National Institute for Health and Care Excellence, 2017). While very preterm infants, particularly those who are discharged on breast milk fortifier, should be weighed once a week, moderate–late preterm infants who were discharged without nutritional support can be weighed according to local guidelines.

There is no consensus on what constitutes normal weight gain for newborns. Work by Lapillonne and colleagues recommends that this should be 13 g/kg/day for infants born at 34–36 weeks' gestational age and 15 g/kg/day for infants born at 32–33 weeks' gestational age, but these are calculated values and not based on real-world evidence (Lapillonne et al, 2013). Rather than follow absolute values, most UK healthcare professionals track the infant's weight on growth charts, interpreting the fit of the infant's growth to the centile lines (Clark et al, 2014).

### Recommendations for identifying poor nutrition

1. Consider separating moderate–late preterm infants based on nutritional needs, for example:
  - Was the infant born at less than 34 weeks’ gestational age?
  - How mature and effective is the infant’s oral motor function?
  - Is the infant producing stool and passing urine in appropriate amounts and frequency?
  - Is there effective breast milk transfer?
  - Is the infant taking sufficient feeds to enable adequate growth?
2. The UNICEF breastfeeding assessment tools are available for use by midwives or health visitors in collaboration with the mother and use several common signs to assess whether an infant is breastfeeding well and safely. These should be considered in this group of infants.
3. Consider routinely referring infants born at 32–36 weeks’ gestational age for assessment by a neonatologist and/or paediatric dietitian before discharge.
4. Consider the mother’s feeding choice and support breastfeeding mothers with a referral to local infant feeding teams if available or specialist lactation support for early support to establish breastfeeding and ongoing support once discharged
5. Monitor growth closely in hospitalised moderate–late preterm infants and continue to do this after discharge until stable weight gain is achieved.
6. Midwives and health visitors should follow National Institute for Health and Care Excellence (2017) guidance or local policy regarding excessive (>10%) weight loss and failure to regain birth weight, and refer these infants to a GP or hospital as per these policies.

While this is an appropriate way to assess growth, it is important to understand the way in which these charts are constructed in order to interpret them correctly, particularly for infants born preterm. The UK-WHO Neonatal and Infant Close Monitoring (NICM) growth chart ([www.who.int/childgrowth/en/](http://www.who.int/childgrowth/en/)) uses two different data sets for its construction. The preterm section uses cross-sectional preterm birthweight data from the UK 1990 dataset. The term section uses the WHO growth standard, a longitudinal dataset based on the growth of term infants fed according to WHO recommendations (ie exclusively breast fed) in six countries from around the world. This means there is a ‘step’ between the preterm and term sides of the chart, so a preterm infant may gain a small amount on its centile line as it moves across from one side of the chart to the other. It is also worth remembering that the chart based on the WHO growth standard uses data on the growth of well term-born infants who were breast fed for the first 6 months, so may not be followed in the same way by preterm infants.

Following the expected initial weight loss, the infant’s weight should then start to follow a centile line, regaining birthweight within 3 weeks as previously described. National Institute for Health and Care Excellence (2017) guidance uses a comparison of the position of the infant’s birth weight on the UK WHO growth charts with subsequent measurements to recommend when weight loss should trigger a referral to a paediatric dietitian or

**Table 1. Triggers for referral to a paediatric dietitian or neonatologist**

Consider using the following as thresholds for concern about faltering growth in infants and children (a centile space being the space between adjacent centile lines on the UK WHO growth charts):

- A fall across one or more weight centile spaces, if birthweight was below the 9th centile
- A fall across two or more weight centile spaces, if birthweight was between the 9th and 91st centiles
- A fall across three or more weight centile spaces, if birthweight was above the 91st centile

*Adapted from National Institute for Health and Care Excellence (2017)*

neonatologist (Table 1). Infants born on a lower centile at birth cannot tolerate such large weight losses as an infant who is larger at birth. Some blood biochemistry measurements may also indicate poor nutrition but are not routinely used in day-to-day practice. Urea levels may provide an indication of how much protein the infant is taking, and low phosphate, sodium, ferritin or vitamin D levels may indicate a need for supplements.

### Nutritional support

Like full-term infants, all moderate–late preterm infants ideally should receive breast milk from birth (Moro et al, 2015). However, while the breast milk of mothers who give birth at term contains all the nutrients their infant needs in the appropriate quantities, moderate to late preterm infants can have both higher requirements than can be provided by breast milk alone, and may also struggle to obtain adequate volumes of breast milk to meet their needs via ad lib breastfeeding as a result of oromotor immaturity. This means that these infants are at risk of suboptimal nutrition and growth faltering, and need nutritional monitoring comprising frequent assessments and contact with healthcare providers, early support and referral to lactation advice from specialist teams.

Historically, there has been little specific, evidence-based guidance on the nutritional needs of moderate–late preterm infants, and this has perhaps resulted in the needs of these infants not being routinely considered. The WHO published guidance on the nutritional needs of low birth weight infants (birth weight <2.5 kg) in 2006 (Edmond and Bahl, 2006), although it should be noted that this was intended to address the needs of low birth weight infants in low income countries where many infants born <2.5 kg will be term infants. Lapillonne and colleagues (2013) reviewed the requirements of these infants, and more recently ESPGHAN have published a position statement on feeding late and moderately preterm infants (Lapillonne et al, 2019). Their recommendations are summarised in Table 2.

Lapillonne and colleagues (2013) calculated that moderate–late preterm infants may theoretically need more calories, protein, and calcium and phosphorous than full term infants to make up the deficits associated with early birth. However, when ESPGHAN considered these and other data in their position paper in 2019, they were unable to make

**Table 2. European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition recommendations for feeding the late and moderately preterm infant**

Hospitals should have their own policies to prevent and treat the known complications associated with late and moderately preterm birth, particularly early hypoglycaemia. Early rooming-in is encouraged and proactive nutritional care and support should be provided

Breast-feeding for late and moderately preterm infants is strongly endorsed. Mothers of late and moderately preterm infants should receive qualified, extended lactation support, and frequent follow up

Healthcare providers should remain vigilant for evidence of poor breast milk transfer and infant problems related to poor intake. Individualised feeding plans should be promoted and should include special considerations to compensate for immature feeding skills and difficulties in establishing lactation and breast-feeding

Individual discharge plans should be developed in every hospital taking into account the local situation and resources. Delayed hospital discharge should be considered if the late and moderately preterm infant does not fulfil the requirements of a safe discharge plan

Late and moderately preterm infants with birth weight <1800 g should receive enteral nutrient supply as described by Agostoni et al (2010)

The use of human milk fortifier, enriched formula and/or additional supplements, and parenteral nutrition may be appropriate for some late and moderately preterm infants, taking into account factors such as gestational age, birth weight and significant comorbidities

Late and moderately preterm infants are at risk of iron deficiency, which may impair neurodevelopment (Berglund et al, 2018). Late and moderately preterm infants weighing <2500 g at birth should receive 1–2 mg/kg/day of iron up to 6 months of age, and those weighing <2000 g should receive 2–3 mg/kg/day of iron at least up to 6 months of age\*

Late and moderately preterm infants require a daily vitamin D supplement of at least 400 IU/day throughout early childhood

*From Lapillonne et al (2019). \*This roundtable group recommends that on discharge these infants should be given this dose and advised to continue until weaned onto a diet containing sufficient iron as assessed by a health professional (preferably a dietitian) or until 1 year of age*

any firm recommendations for nutrient intake because of a lack of data, although they recognised a need for active nutritional support, especially in those born more preterm (Lapillonne et al, 2019). These infants may also need additional iron and vitamins A and D (Lapillonne et al, 2013, 2019; Uijterschout et al, 2015).

### Breastfeeding

The National Institute for Health and Care Excellence (2017) recommends that mothers of moderate–late preterm infants who are breastfeeding be given advice and support to increase their milk supply. This advice can include assistance to ensure the infant is helped to take as much breast milk as it needs through expert breastfeeding support. In addition mothers will benefit from carrying on expressing additional milk until the infant is around term by which time their oromotor function should have matured sufficiently. This will help to match the mother’s milk supply to what the infant will need once they are able to fully breastfeed. Skin to skin contact and encouraging the infant to fully feed from one breast to ensure it obtains the fat-rich hind milk can also be encouraged (National Institute for Health and Care Excellence, 2017; Mekonnen et al, 2019; Wang et al, 2021), although during hot weather it is important to let the infant take frequent small feeds if he/she asks for this to ensure adequate hydration.

Some of these infants may be eligible for donor breast milk if they are especially low birth weight or sick, although this will depend on the availability of donor milk and associated policies in individual institutions. Psychologically, donor breast milk may be more acceptable than formula milk to mothers whose infants need supplementary feeding, and may in turn encourage continuation of breastfeeding (Kair and Flaherman, 2017).

For late preterm infants, tube feeding may be useful for infants in whom full oral feeding has not yet matured. These infants can stay with their mothers on the postnatal ward or can be discharged home with the tube in place. In both instances they can develop their breastfeeding skills and have nasogastric top ups to make up any shortfall until the infant is taking the full amount of milk they need orally. Discharging a mother and infant home with a nasogastric tube in place could facilitate breastfeeding by allowing the pair to be close and develop their feeding relationship, and avoid the mother having to travel into the hospital and spend long periods separated from her infant. It is also better for the infant to be at home and away from the risk of hospital-acquired infections. In addition, if breast milk fortifier is to be given it can be administered via the nasogastric tube.

Although an increased volume of milk can increase nutrient intake, there is a physical limit to the volume of feed these small infants are able to tolerate. If increasing the volume of breast milk is insufficient to address the infant’s nutritional needs and improve growth, it is important to assess how effective feeding is, and if it is felt to be adequate, consider whether there is a need to supplement the mother’s breast milk, ideally using a breast milk fortifier.

### Breast milk fortifier

The role of breast milk fortifier post-discharge was the subject of an earlier roundtable meeting, which found that it provided significant potential benefits for infants who required additional nutrition (McCormick et al, 2021).

ESPGHAN guidelines recommend that infants weighing <1800 g at birth should receive breast milk with breast milk fortifier containing protein, minerals and micronutrients (Agostoni et al, 2010; Moro et al, 2015; Lapillonne et al, 2019). Currently in the UK the decision to add fortifier is either empirical based on calculated nutrient intakes vs requirement or on the basis of poor growth. For exclusively breastfed infants, breast milk fortifier can be given by mouth as a concentrate (ie a sachet mixed with a few mls of expressed breast milk or sterilised water) during or after a breastfeed (McCormick et al, 2021).

Infants receiving fortifier must be monitored to ensure that they are growing and to assess when the fortifier can be reduced and eventually discontinued (McCormick et al, 2021). This requires weekly weighing and other measurements as well as observation of the infant’s feeding habits and whether they are showing signs of successful milk transfer. Liaison between the hospital team and the community team is essential to ensure monitoring is carried out appropriately, with the neonatal or paediatric team guiding the parents and community team on any changes in the fortifier administration or dose (McCormick et al, 2021).

## Formula feeding

Where a mother has chosen to formula feed she should receive the support she needs to ensure that her baby can safely and effectively bottle feed. When an infant is receiving all formula or some top ups of formula there may be an advantage to using a specialised formula rather than a term version. Mothers who are partly breastfeeding but are medically or dietetically advised to supplement their infants with formula should continue to be encouraged and helped to breastfeed and not to see the need for formula as a failure. There is evidence that formula fed preterm infants are much more prone to constipation post discharge compared to breast milk fed (Zachariassen and Fenger-Gron, 2014). There are three types of formula milk – preterm formula, nutrient-enriched post-discharge formula or standard term formula – which differ according to their nutrient composition, with preterm formula having the highest levels (nutritional values for these are available on company websites).

Preterm formula is designed primarily for preterm infants. Agostoni et al (2010) recommend preterm formula for infants weighing <1800 g and post-discharge formula is helpful for transitioning infants from preterm to standard term formula (ESPGHAN Committee on Nutrition et al, 2006) – otherwise for some infants the reduction in nutrient intake might be too large and result in poor growth, or cause the infant to attempt to take in very large volumes of milk (Lucas et al, 1992) which might be problematic for the infant ie very frequent feeding and risk of reflux like symptoms. This observation, coupled with improved growth in studies using this formula, led to the development and subsequent availability of post-discharge formulas (Lucas et al, 2001).

Nutrient-enriched post-discharge formula is intended for infants born less than 35 weeks' gestational age and/or weighing <2000 g and is only available on prescription. It should be reserved for infants at risk of, or currently experiencing persistent poor growth at discharge. Its use should be agreed with the infant's GP and health visitor. Evidence to support its use

### Recommendations for nutritional support

1. Mothers of all moderate–late preterm infants should be encouraged to breastfeed and be supported to do so. They should be referred to local infant feeding teams for specialist support because of the additional challenges of establishing breastfeeding in preterm infants. While infants are inpatients strategies may include expressing milk that can be fed to the infant from a spoon, a cup or via a nasogastric tube if necessary, depending on whatever the preferred method and expertise are at the hospital of birth. However, spoon and cup feeding are not encouraged outside of a hospital setting, and home nasogastric tube feeding requires community support.
2. Where available and appropriate, donor milk may be offered as a first step to supplement mother's breast milk in the early days when there is a shortfall of mother's milk.
3. Follow ESPGHAN, National Institute for Health and Care Excellence and/or local guidelines concerning the introduction of breast milk fortifier for infants who need extra nutrition.
4. Consider tube feeding of expressed breast milk with or without breast milk fortifier where this would help the infant and mother to stay together, avoid the need for introduction of bottle feeding and facilitate earlier discharge.
5. Where early discharge is possible, liaise with the community midwives and health visitors to ensure that the infant and its parents will receive adequate follow-up and support.
6. If there is insufficient mother's breast milk for the infant's needs, it should receive an appropriate formula, ideally as a supplement to any breast milk that is available.
7. Follow the ESPGHAN weight-based guidelines when selecting the most appropriate formula for the infant's needs.
8. Consider prescribing iron supplements for all infants born at or before 35 weeks' gestational age and a vitamin supplement containing 400 IU of vitamin D for all infants born at or before 35 weeks' gestational age if they are not receiving exclusive preterm formula.

is mixed (Young et al, 2016); it can be of benefit up to 3 months' post-term corrected age but not beyond 6 months' post-term corrected age. Term formula can be offered to infants born from 35 weeks' gestational age, although growth should be monitored carefully as it may be nutritionally inadequate for some late preterm infants. However, there is some evidence that post-discharge formulas are not of benefit to term or near term infants that are small for gestational age (Morley et al, 2004; Singhal et al, 2007).

### Making use of the multidisciplinary team

Infants who have had a straightforward birth and postnatal period generally thrive under the care of a midwife and health visitor. Mothers who need additional support with breastfeeding may be referred to an infant feeding advisor. Some moderate–late preterm infants may be hospitalised for a brief time after birth and may be seen by a neonatologist or paediatrician and/or a paediatric dietitian and/or a speech and language therapist in addition to the midwives before discharge. Follow-up may be with the hospital or in the community.

Post-discharge, poor growth and other feeding issues will most likely be picked up by the health visitor or midwife. Depending on the infant's history and/or the severity of the situation, the health visitor or midwife may refer the infant to their GP or a paediatrician, paediatric dietitian or lactation consultant for follow up.

### Need for further research

There are a number of areas where further research would be beneficial. First, better understanding of the scale of the problem is needed through good audit practices, in terms of the numbers of moderate–late preterm infants with nutrition and growth issues, readmission rates and other short- and long-term outcomes. More work is needed to understand the nutritional needs, patterns of growth and potential interventions for these infants to improve outcomes. Such evidence would support the development of local and/or national policies for moderate–late preterm infants. Further evidence is also needed to support recommendations for use of post-discharge formula.

### Conclusions

Limited published evidence is available to support the management of the nutritional needs of moderate–late preterm infants to optimise their growth and development. The authors of this article make recommendations for practice both in hospital and in the community to support infants and their parents.

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### Recommendations for the multidisciplinary team

1. The findings of the pre-discharge assessment of moderate–late preterm infants should be carefully communicated to their GP, community midwife and health visitor.
2. The community team should be clear about when and where to refer the infant in the event of poor growth or feeding difficulties.

## Key points

- During the third trimester of pregnancy, important biochemical and structural changes take place in the fetal brain and body, and energy and nutrients are stored for use perinatally. Late preterm infants therefore lack the full benefit of this in utero development and laying down of stores.
- The nutritional requirements for optimal growth and development of moderate and late preterm infants are not known, although they appear higher than those of term infants.
- Moderate and late preterm infants at risk of poor growth should be monitored to ensure that they are receiving sufficient nutrition.
- Mothers of moderate and late preterm infants should be fully supported in their choice to provide breast milk for their infants and breastfeed.
- All members of the multidisciplinary team in hospital and the community should be aware of these infants to ensure they continue to thrive and that breastfeeding continues to be supported.

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## Conflicts of interest

The authors declare that they have no conflicts of interest.

## Funding

This roundtable discussion was supported by an educational grant from Nutricia. Nutricia have reviewed this article for factual accuracy, but had no influence on the discussion. Participants were offered an honorarium for the time spent preparing for and participating in the roundtable – all participants declined the honorarium.

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