Feeding the Late and Moderately Preterm Infant: A Position Paper of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition

*†Alexandre Lapillonne, ‡Jiri Bronsky, §Cristina Campoy, ||Nicholas Embleton, ¶Mary Fewtrell, #Nataša Fidler Mis, **Konstantinos Gerasimidis, ††Iva Hojsak, ‡‡Jessie Hulst, §§Flavia Indrio, ||||Christian Molgaard, ¶¶Sissel Jennifer Moltu, ##Elvira Verduci, and ***Magnus Domellöf, ESPGHAN Committee on Nutrition

ABSTRACT

Nutritional guidelines and requirements for late or moderately preterm (LMPT) infants are notably absent, although they represent the largest population of preterm infants. The European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) Committee on Nutrition (CoN) performed a review of the literature with the aim to provide guidance on how to feed infants born LMPT, and identify gaps in the literature and research priorities. Only limited data from controlled trials are available. Late preterm infants have unique, often unrecognized, vulnerabilities that predispose them to high rates of nutritionally related morbidity and hospital readmissions. They frequently have feeding difficulties that delay hospital discharge, and poorer rates of breastfeeding initiation and duration compared with term infants. This review also identified that moderately preterm infants frequently exhibit postnatal growth restriction. The ESPGHAN CoN strongly endorses breast milk as the preferred method of feeding LMPT infants and also emphasizes that mothers of LMPT infants should receive qualified, extended lactation support, and frequent follow-up. Individualized feeding plans should be promoted. Hospital discharge should be delayed until LMPT infants have a safe discharge plan that takes into account local situation and resources. In the LMPT population, the need for active nutritional support increases with lower gestational ages. There may be a role for enhanced nutritional support including the use of human milk fortifier, enriched formula, parenteral nutrition, and/or additional supplements, depending on factors, such as gestational age, birth weight, and significant comorbidities. Further research is needed to assess the benefits (improved nutrient intakes) versus risks (interruption of breast-feeding) of providing nutrient-enrichment to the LMPT infant.

Key Words: breast-feeding, growth restriction, premature infants, recommendations

(*JPGN* 2019;69: 259–270)

What Is Known

- Late or moderately preterm infants represent the largest population of preterm infants.
- Late preterm infants frequently have feeding difficulties that delay hospital discharge, and poorer rates of breastfeeding initiation and duration compared with term infants.
- Moderately preterm infants frequently experience postnatal growth restriction.

What Is New

- The European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee of Nutrition strongly endorses breastmilk as the preferred method of feeding and emphasizes that mothers should receive qualified and extended lactation support.
- The need for active nutritional support increases with lower gestational ages but research is needed to assess the benefits versus risks of providing nutrient enrichment in these infants.

In recent years, much attention has been focused on enhancing the nutritional support of very preterm infants to improve both survival and longer term outcomes. Significant efforts have been made to

Received January 9, 2019; accepted May 2, 2019.

From the *Paris Descartes University, APHP Necker-Enfants Malades hospital, Paris, France, the †CNRC, Baylor College of Medicine, Houston, TX, the ‡Department of Paediatrics, University Hospital Motol, Prague, Czech Republic, the §Department of Paediatrics, University of Granada, Spain, the ||Newcastle Neonatal Service, Newcastle Hospitals NHS Trust and Newcastle University, Newcastle upon Tyne, UK, the ¶Childhood Nutrition Research Centre, UCL GOS Institute of Child Health, London, UK, the # Department of Gastroenterology, Hepatology and Nutrition, University Children's Hospital, University Medical Centre Ljubljana, Slovenia, the **Human Nutrition, School of Medicine, Dentistry and Nursing, University of Glasgow, New Lister Building, Glasgow Royal Infirmary, Glasgow, UK, the ††Children's Hospital Zagreb, Croatia, University of Zagreb School of Medicine, the ‡‡Division of Gastroenterology, Hepatology and Nutrition, Hospital for Sick Children, Toronto, Canada, the §§Ospedale Pediatrico Giovanni XXIII University of Bari, Italy, the ||||Department of Nutrition, Exercise and Sports, University of Copenhagen, and Pediatric Nutrition Unit, Copenhagen University Hospital, Rigshospitalet, Denmark, the ¶¶Department of Neonatal Intensive Care, Oslo University Hospital, Norway, the ##Department of Pediatrics, San Paolo Hospital, Department of Health Sciences, University of Milan, Mian, Italy, and the ***Department of Clinical Sciences, Pediatrics, Umeå University, Umeå, Sweden.

improve the provision of adequate nutrition during their in-hospital course stay and during the first months of life. In the preterm population weighing less than 1800 g, nutritional requirements have been reviewed (1). Similarly, nutritional requirements for term-born infants during the early months of life have also been re-evaluated to more closely match the nutritional intakes of breast-fed term infants (2).

Nutritional requirement guidelines for late and moderately preterm (LMPT) infants are notably absent despite them representing the largest population of preterm infants. Feeding regimens designed specifically to meet the nutritional requirements of LMPT infants have not been established and need consideration. Therefore, the aim of this European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) committee on nutrition (CoN) position paper is to critically review the available evidence on the role of nutrition in infants born LMPT, to provide guidance on how best to feed these infants, and identify gaps in the literature and research priorities.

DEFINITIONS AND SCOPE OF MANUSCRIPT

Despite widespread agreement in defining preterm birth, there is less uniformity in defining different subgroups. The common subgroup terminologies used are very preterm (less than 32 weeks) and extremely preterm (less than 28 weeks). In contrast, a variety of terms have been used to describe preterm infants born at a number of different intervals between 32 and 36 weeks' gestation (''late preterm,'' ''near term,'' ''marginally preterm,'' ''moderately preterm,'' ''minimally preterm,'' ''mildly preterm'', and ''larger preterm''). An expert panel at a workshop convened by the National Institute of Child Health and Human Development (NICHD) of the National Institutes of Health (NIH) in July 2005 recommended that births between 34 completed weeks (34 0/7 weeks) and less than 37 completed weeks (36 6/7 weeks) of gestation be referred to as ''late preterm'' (3). Specifically, this discourages the use of the phrase ''near term,'' which may suggest that the infant is almost term, whereas the phrase ''late preterm'' emphasizes that these infants are at risk of immaturity-related medical complications (3). Although there has been no such consensus for a classification of birth between 32 completed weeks (32 0/7 weeks) and less than 34 completed weeks (33 6/7 weeks), ''moderately preterm'' is now commonly used.

The term ''low birth weight'' is a widely accepted definition for newborns with a birth weight below 2500 g. Use of this term, however, does not discriminate those infants with a low birth weight because of prematurity from those born small for gestational age (SGA) or in-utero growth restricted (IUGR) at term. SGA/IUGR infants may not have achieved full in-utero growth potential often because of a complex range of genetic, epigenetic, maternal, and environmental factors and present increased risks for specific short-term and long-term morbidities. The most frequent cause of IUGR is placental insufficiency, which impacts foetal growth and many physiological and development processes (4). It is tempting to extrapolate these observations to preterm infants as they, too, are almost always born LBW. Many preterm infants, however, have normal or relatively normal growth before birth, meaning the optimal nutritional management may differ between a LBW infant born preterm and a LBW infant born at term who is IUGR.

The definitions of LMPT indicated above have been used throughout this report.

METHODS

A systematic literature search was conducted up to April 13, 2018. For each outcome of interest relating to the nutrition of LMPT infants, searches were conducted in the databases Medline (via PubMed) and the Cochrane Library for relevant publications in English, including original articles, systematic reviews, and meta-analyses—see Appendix 1. Specific features relating to late preterm (LPT) or moderately preterm (MPT) infants have been reviewed and reported separately whenever possible. Recommendations were formulated and discussed in a total of 3 face-to-face meetings, which were held in Geneva, Rotterdam, and Zagreb. Between meetings, CoN members interacted by iterative e-mails. All disagreements were resolved by discussion until a full consensus was reached for every statement. Similarly to the rules provided by ESPGHAN for Guidelines (*http://www.espghan.org/fileadmin/user_upload/Society_Papers/ESPGHAN_-_Overview_ESPGHAN_Publications_January_2018.pdf*), final agreement for each conclusion and recommendation was assessed anonymously using a web-based questionnaire enabling a list of arguments for and against each conclusion and recommendation. This possibility also allowed members to suggest new conclusions and/or recommendations to be submitted to the panel. One round of questionnaires was sufficient to reach consensus of >85% for all conclusions and recommendations.

BACKGROUND

Epidemiology and Common Morbidities of Late or Moderately Preterm Infants

The incidence of preterm birth in different countries varies widely (5) as does that of LMPT infants with a rate less than 4% in

Address correspondence and reprint requests to Alexandre Lapillonne, MD, PhD, Neonatal Department, Necker-Enfants Malades hospital, 149 rue de Sevres, 75015 Paris, France (e-mail: alexandre.lapillonne@aphp.fr).

M.D. is the Chair and J.B. is the Secretary of Committee on Nutrition.

A.L. received lecture fees and/or nonfinancial support from Baxter, Fresenius, Nestle, and Mead Johnson Nutrition. J.B. reports personal fees and nonfinancial support from AbbVie, Nutricia, Biocodex, personal fees from MSD, Nestlé, Ferring, Walmark, outside the submitted work. C.C. received research funding from ORDESA Laboratories, S.A. N.E. reports receipt of grants/research supports from National Institutes for Health Research (UK), Prolacta Bioscience (US) and Danone Early life Nutrition. He also served as member of Advisory board for Danone Early life Nutrition and received payment/honorarium for lectures from Danone Early life Nutrition, Nestle Nutrition Institute, Baxter and Fresenius Kabi. M.F. receives research funding from Philips and has received honoraria for lectures from the Nestle Nutrition Institute and for co-editing a book chapter on growth from Danone Early Life Nutrition. K.G. reports personal fees from Nutricia, research grants and personal fees from Nestle, and Nutricia and personal fees from Dr Falk. I.H. reports receipt of payment/honorarium for lectures BioGaia, Nutricia, Nestle, GM pharma, and of payment/honorarium for consultation Farmas, Chr Hansen. F.I. reports receipt of payment /honorarium for lectures Biogaia, Nestle, Danone, Abbot. Consultant for Biogaia. S.J.M. reports receipt of grants/research supports from DSM Nutritional Products, she served as member of advisory board and received payment/honorarium for consultation from Baxter and received payment/honorarium for lectures from Baxter and Fresenius Kabi. E.V. reports grant/research support from Nutricia Italia Spa, Nestle Health Science—Vitaflo Italy, FoodAR srl Italy, PIAM Pharma, and Integrative Care. M.D. reports a research grant from Baxter and speaker fees from Semper, Baxter, Nutricia, and Abbvie. The remaining authors (N.F.M., J.H., and C.M.) report no conflicts of interest.

Disclaimer: ESPGHAN is not responsible for the practices of physicians and provides guidelines and position papers as indicators of best practice only. Diagnosis and treatment is at the discretion of physicians.

The authors report no conflicts of interest

DOI: 10.1097/MPG.0000000000002397

Scandinavia and up to 10% in Korea (6–9). Interestingly, when moderate- and late-preterm are combined, the LMPT population represents more than 80% of all preterm births and consume about one-third of all hospital expenditures related to prematurity (10,11).

Although serious morbidities are rare, LMPT infants have a 2- to 10-fold increased incidence of mild-to-moderate morbidities compared with term infants including hypothermia, respiratory distress, jaundice, and infection. These infants are also prone to develop nutritionally related neonatal morbidities, such as hypoglycaemia, poor feeding, dehydration, and malnutrition in the early neonatal period (12–18). Several studies have shown that LMPT infants are 2 to 3 times more likely to be readmitted after initial hospital discharge because of multiple factors including jaundice, sepsis, and feeding difficulties (17,19–21).

Hypoglycaemia

Our systematic literature search identified 6 studies on hypoglycaemia rates in the LMPT population. The incidence of early hypoglycaemia (within the first 12 hours of life) was 3 to 4 times greater in the LPT infants as in the term infants, with 1 of 3 experiencing recurrent episodes of hypoglycaemia (22). The rate of hypoglycaemia ranged from 16 to 34% and was associated with lower GAs (9,22,23), the risk being further increased in infants born at 34 weeks compared with those born at 35 to 36 weeks of gestation (9,24). In a large retrospective cohort study from Australia, including 735 LMPT infants, the rate of hypoglycaemia was similar to the rates found in LPT infants: 22% in the LMPT appropriate for gestational age (AGA) infants, increasing to 32% in the LMPT small for gestational age (SGA) infants (25). This rate is higher than the 13% observed in MPT infants from a multicentre observational study in France, which included infants with GA as low as 30 weeks (26). Interestingly, in a randomized controlled trial that aimed to determine the efficacy of a proactive feeding regimen in reducing hospital length of stay in MPT born small for gestational age (SGA) infants (27), one-third of the group receiving standard care ($60\,mL \cdot kg^{-1} \cdot day^{-1}$ of human milk at day 1 followed by a gradual increase to $170\,mL \cdot kg^{-1} \cdot day^{-1}$ by day 9) developed hypoglycaemia compared with none in the proactive feeding group ($100\,mL \cdot kg^{-1} \cdot day^{-1}$ of human milk on day 1, followed by $130\,mL \cdot kg^{-1} \cdot day^{-1}$ on day 2, $165\,mL \cdot kg^{-1} \cdot day^{-1}$ on day 3, and $200\,mL \cdot kg^{-1} \cdot day^{-1}$ from day 4). This significant reduction in the incidence of hypoglycaemia by a proactive regimen in a risk subgroup of LMPT (ie, MLT born SGA) suggests that enhanced feeding support may reduce the risk of hypoglycaemia in LMPT infants.

Taken together, these studies show that LMPT infants are at high risk of hypoglycaemia, and this is because of numerous factors including immature gluconeogenesis, lower hepatic glycogen reserves, and a weaker peripheral counter-regulatory ketogenic response because of inadequate lipolysis exacerbated by low adipose tissue stores and inadequate milk intake (24). However, in part, hypoglycaemia may simply be because of a lack of early feeds including delayed initiation or use of low volumes, and/or a lack of PN when early feeding is not initiated (24,28). The findings of the randomized controlled trial cited above strongly support the hypothesis that LMPT infants should not be treated as term infants, but deserve specific nutritional care, including proactive nutritional support for the prevention of hypoglycaemia.

Postnatal Growth Restriction

Postnatal growth restriction (PGR) has been identified as a major problem reflecting suboptimal nutrition of very preterm infants. Five studies assessed growth of LPT infants. In a population-based cohort of all births in 2004 in Brazil, LPT infants were at increased risk of being underweight (ie, weight-for-age z-scores below -2) and stunted (ie, length-for-age z-scores below -2) at 12 and 24 months of age compared with term infants (adjusted OR: 2.57 95% confidence interval [CI] 1.27–5.23] and 2.35 [95% CI 1.49–3.70], and 3.36 [95% CI 1.56–7.23] and 2.30 [95% CI 1.40–3.77], respectively) (29). In a large cohort of 7866 US infants, LPT infants had a significant increased risk of having a weight-for-age z score of -2 or less at 6 months (adjusted OR 3.48 [95% CI 2.17–5.72]) and 12 months (2.22 [1.07–4.61]) but not at 18 months (30). In contrast, 108 LPT infants in a large cohort of 2465 children born in Beijing, China, exhibited complete catch-up in weight, length, and ponderal index by 1 year of age (31). In another study from China, the difference in weight and length of LPT infants compared with term infants decreased significantly with age during the first year of life ($P < 0.001$) but only weight demonstrated complete catch-up at 12 months corrected age (32). Finally, 1107 LPT infants from a large observational cohort in the United Kingdom exhibited a lower weight (-0.2 kg [-0.5 to 0.0] and -0.3 kg [-0.6 to -0.1], respectively) and height (-0.8 cm [-1.1 to -0.4] and -0.8 cm [-1.3 to -0.4], respectively) at 3 and 5 years compared with their term counterparts (33), yet exhibited a similar risk of being overweight at 3 and 5 years as their term counterparts. It is clear that growth patterns of LPT infants in these countries differ, suggesting that population context and perhaps nutritional practices have the potential to modify outcomes of LPT infants during the first years of life. Whether or not poor early growth of LPT infants is linked to inadequate early nutrition remains to be determined.

Five studies report growth in MPT premature infants, 2 during hospitalization, and 2 during the first 4 years of life. In a study performed in 15 neonatal intensive care units (NICUs) in the United States, only 2% of the MPT infants achieved growth rates approximating those in-utero ($15\,g \cdot kg^{-1} \cdot day^{-1}$) during neonatal hospitalization (34). The average decrease of weight z-score from birth to discharge was 0.67 (95% CI -1.98 to 0.22), with large variations across neonatal units, ranging from 0.45 to 0.93. A significant association existed between low protein and energy intake and reduced growth velocity. Continued use of supplemental gavage feeding at 35 weeks GA (ie, intermittent enteral nutrition) was associated with a higher net growth velocity, than subjects not receiving any gavage supplement (7.0 ± 4.6 vs $5.0 \pm 5.8\,g \cdot kg^{-1} \cdot day^{-1}$, $P < 0.001$), suggesting that the end of gavage feeding may reflect variation in recognition rather than the attainment of mature feeding, and that gavage feeding may be discontinued sooner than desirable to enable optimal growth (34). In a French study, premature infants born either very preterm (ie, 30–31 weeks of gestation) or MPT had a 24% chance of having a weight below the 10th percentile at 36 weeks postconceptional age (PCA) (26).

In a large community-based cohort of 1123 MPT infants born in the Netherlands, MPT infants were shorter and weighed less at each assessment during the first 4 years of life than their term-born counterparts (35). At 4 years of age, the preterm boys were 0.15 standard deviation (SD) lighter ($P = 0.09$) and 0.3 SD ($P = 0.01$) shorter and the preterm girls were 0.25 SD lighter ($P = 0.01$) and 0.2 SD ($P = 0.04$) shorter. At 7 years of life, a subgroup of 234 of these infants remained slightly shorter and lighter than reference values (-0.12 SD and -0.21 SD, respectively) (36). Being SGA at birth was identified as a strong predictor of final weight and height for both symmetrical (ie, head circumference is in proportion to weight and length) and asymmetrical (ie, only weight and length are reduced) growth restricted preterm-born infants (37). Of note, those born large for gestational age (ie, birth weight >90th percentile) demonstrated well balanced growth in height, weight, and head circumference during infancy but an accelerated weight gain during subsequent years leading to a BMI similar to that of LGA-term babies (38).

In a longitudinal population-based study in Japan including 1414 LPT and 25,556 term infants, the incidence of short stature (height <−2 SD for their age) was 2.9% in the LPT infants, which was significantly higher than in the term infants (1.4%). This study also showed that short stature was more common in LPT SGA infants (9.4%) compared with LPT AGA infants (2.1%) (39).

Finally, the 147 MPT infants of a large observational cohort from the United Kingdom exhibited a lower weight (−0.8 kg [−1.2 to −0.4] and −1.2 kg [−1.7 to −0.7], respectively) and height (−0.9 cm (−1.9 to 0.0) and −1.3 cm (−2.3 to −0.3), respectively) at 3 and 5 years compared with their term counterparts (33). Contrarily to what was observed in LPT who exhibited a similar risk of being overweight than their term counterparts, MPT exhibited a lower risk of overweight at 3 and 5 years. Overall, these studies in LMPT infants show that they are at risk of being shorter and lighter during childhood than their term counterparts, but also have a lower risk of being overweight.

Altered Body Composition

Our systematic search identified 3 studies assessing early body composition of LMPT using reliable methods. In the first study, predominantly breast-fed healthy MPT infants at term post-conceptional age were significantly lighter than full-term newborns, but had a similar proportion of body fat and subcutaneous fat when assessed by magnetic resonance imaging (40). The total body water using the doubly labelled water methodology was also similar between the 2 groups confirming similar body composition (40).

In a cohort study published in several manuscripts, body composition of the LPT infants was assessed by air displacement plethysmography. In a first set of data on a limited number of patients (n = 49), the LPT infants had a similar fat content at 3 months corrected age than term infants ages 3 months, despite a transient higher percentage of fat at term corrected age and at 1 month corrected age (41). This transient increase in adiposity, which may simply come from the comparison of a newborn infant with one who is several weeks old, was confirmed by a second set of data of 216 LPT infants (42). Among the factors studied, intrauterine growth was not significantly associated with postnatal body composition changes, but more human milk feeding appeared to be associated with increased fat-free mass deposition (43,44).

Finally, the third study assessed body composition using air displacement plethysmography in a group of 25 LMPT infants at expected term. The LMPT infants had a similar weight but a lower fat-free mass and a higher fat mass than term infants matched for body weight and gestational age (45).

These observations suggest that LMPT infants may have a transient excess of fat at expected term when compared with term infants measured at birth, although the clinical relevance of this finding remains to be studied.

Feeding and Eating Difficulties

Feeding difficulties are the primary reason for prolonged hospital admission of LPT infants and up to 3/4 of LPT infants require feeding support (46). These feeding difficulties are related to gestational age being more frequent in infants born at 34 weeks compared with those born at 35–36 weeks of gestation (30% vs 9%) (9). This is related to immaturity of multiple physiological processes including cardiorespiratory instability, metabolic disturbances, immaturity of state regulation, uncoordinated suck, swallow, breathe organization, and decreased oromotor tone (46,47). Furthermore, the risk of feeding difficulties may also be increased by maternal conditions (eg, obesity, multiple births, pregnancy-induced hypertension, infections) causing or associated with preterm delivery (46). Successful feeding is sometimes not sustained after discharge and this may result in readmission, and this may be because of being discharged home before problems with latch and milk transfer have been resolved. Parental education and timely outpatient follow-up by a provider knowledgeable in breast-feeding seem crucial in the proper management of breast-feeding for these mother-infant dyads (48).

In a postdischarge parental survey of 571 LPT infants, symptoms compatible with oromotor dysfunction (17%) and avoidant feeding behaviour (29%) were frequently reported at 3 months of age (49). The most commonly reported form of oromotor dysfunction was choking and the most common avoidant feeding behaviour was spitting. The rates of oromotor dysfunction and avoidant feeding behaviour decreased over time to reach 4% and 12% at 1 year, respectively. The only difference between LPT infants who were admitted to the NICU and those admitted to the term nursery was that those admitted to the NICU were twice as likely to require hospitalization or specialty care before 3 months (16% vs 8%; $P = 0.009$).

Increased risk of eating difficulties at 2 years of age has been recently documented in a large population-based cohort of 1130 LMPT and 1255 term born controls (50). Infants born LMPT were at increased risk of oral motor (RR 1.62; 95% CI 1.06–2.47) and picky eating problems (RR: 1.53; 95% CI 1.03–2.25) at 2 years corrected age but these observations were mediated by other neurobehavioral sequelae in this population. Whether or not LMPT infants are at risks of long-term feeding disorders requires further study.

Neonatal Nutrition and Long-term Cardiovascular and Metabolic Outcomes

It remains uncertain whether the transient altered body composition observed in LMPT infants at term persists into later life, and if so, whether this may be mediated by early nutrition. Up until 3 months of age, fat mass accretion of LPT infants is not associated with early perturbation of glucose homeostasis (42). A population-based study from Sweden showed that children born LMPT are significantly leaner at 5 years than those born at term (51). This longitudinal study showed a transient larger waist circumference at 2 years in the LMPT group, which was not apparent later (51). Compared with healthy control children born at term, a group of appropriate for gestational age LMPT children exhibited lower weight at 3.5 years, smaller height at both 3.5 and 7 years, similar skinfold thicknesses at 3.5 years and similar fat mass and percentage fat at 7 years (52). Lean mass assessed by dual X-ray absorptiometry was, however, reduced at 7 years compared with the controls in absolute value but not when adjusted for height (52).

In a population-based cohort study, which included 329,495 Swedish men born in 1973 to 1981, the adjusted odd ratios (95% CIs) for high systolic blood pressure (BP) (≥140 mmHg) was 1.25 (1.19–1.30) in preterms born between 33 and 36 weeks of gestation (53). Compared with very preterm infants, the risk observed in LMPT infants is lower, but still significantly higher than in term infants. Furthermore, 1 large prospective study performed in New Zealand, which included 311 adults born MPT and 147 adults born at term, showed that moderate prematurity was associated with increased systolic BP by 3.5 mmHg at age 30 (95% CI 0.9–6.1 mmHg, $P = 0.009$). Overall the risk of hypertension was significantly increased in preterm versus term born adults (20% vs 10%, respectively; $P = 0.01$) (54). Finally, a case-control study with a limited number of patients (22 adults born MPT vs 14 adults born

at term) but using a detailed measure of BP (ie, 24-hour ambulatory BP monitoring) showed that mean 24-hour arterial pressure and both nocturnal and daytime diastolic BP were significantly increased in adults born MPT (55).

Insulin resistance or glucose intolerance in very preterm patients may develop during childhood, but is more commonly observed in adulthood (56). In a large cohort study, response to a standard 75 g oral glucose tolerance test demonstrated that young adults born LMPT have decreased insulin sensitivity compared with adults born at term (54). Decreased insulin sensitivity was further confirmed in a nested study using hyperglycaemic clamps, the gold standard method for assessment of insulin sensitivity (57). These adults (at 34–38 years) born preterm had greater abdominal adiposity, increased truncal fat, and higher android to gynoid fat ratio compared with those born at term (58). Furthermore, they exhibited a compensatory increased first-phase insulin secretion, but similar disposition index, indicating an appropriate insulin secretion (57).

Whether or not cord lipoprotein profiles at birth or during the first month of life in LPT infants translates into long-term effects is not known (59,60). In the New Zealand study described previously, young adults born LMPT did have altered blood lipid and early morning cortisol levels at age 30 years (54), and those followed to 34 to 38 years exhibited a less favourable lipid profile, including lower HDL-C concentrations and greater total cholesterol to HDL-C ratio (58).

A few studies have assessed bone development and the risk of bone disease in LMPT infants by the use of dual-energy X-ray absorptiometry. At 1 year corrected age, a minimal difference of less than 1% of the bone mineral density (BMD) of the lumbar spine was found in LMPT infants compared with infants born full term (32). At 7 years, bone mineral content (BMC) was reduced in LMPT infants compared with the controls in absolute value but not when adjusted for height (52). At 31 years of age, birth weight, independent of gestational age, was positively associated with lumbar spine BMC, area, and areal BMD (61). These associations, however, disappeared when adjusted for adult height, indicating that LMPT infants have appropriate bone development in adulthood (61).

These limited data suggest that the cardiovascular and metabolic risk profiles in LMPT are similar to features observed in very preterm infants. Our review highlights the lack of data on the effects of nutrition during hospitalization or after discharge on later metabolic risks and emphasize that further studies are needed to determine the long-term impact of early nutrition.

Neonatal Nutrition and Long-term Neurological Outcomes

Although multiple studies have focused on the neurodevelopment of very preterm infants, there is increasing evidence that LMPT infants are also at increased risk of impaired neurodevelopment. A systematic review shows that LPT infants are at increased risk of adverse developmental outcomes and academic difficulties up to 7 years of age in comparison to term infants (62). Whether or not developmental delay of LMPT infants is affected by early nutrition remains unclear. It is likely that several nutritional factors, combined or independently, may affect development of LMPT infants.

As large changes in plasma sodium concentrations have been found to be associated with later adverse development of very preterm infants (63), it is reassuring that data from a large observational study showed that term and LPT infants with neonatal dehydration were not at risk of abnormal neurologic examinations or neurologic diagnoses at 5 years of age (64).

A study performed in 225 LPT infants born in Northern Ireland showed no significant association between growth and cognitive, motor, or language skills assessed by the Bayley Scales of Infant and Toddler Development, Third Edition (65). In contrast, short stature during the first 7 years of life was associated with poorer motor, IQ, and attention scores and was associated with increased risks of impaired motor skills and low IQ in a group of 234 MPT children (36). Lower weight at 1 and 4 years was associated with lower IQ scores, whereas accelerated weight gain between age 4 and 7 years was associated with poorer motor, IQ, and attention scores (36). A large cohort of 1130 LMPT infants has been studied at 2 years corrected age by using questionnaires assessing the risk of neurosensory and cognitive impairment (66). Compared with the 1255 term-born infants, the LMPT infants had twice the risk for neurodevelopmental disability at 2 years of age with the vast majority of identified impairments in the cognitive domain. Not receiving breast milk at discharge was identified as an independent risk factor for cognitive impairment (66). Together with similar studies performed in very preterm infants these studies suggest that long-term neurological outcomes of LMPT infants may be modified by breast-feeding and early nutrition.

CURRENT NUTRITIONAL PRACTICES

Observed Nutritional Practices

Benchmarking or comparative studies often show that care of preterm infants, including nutritional practices varies greatly among countries and centres. The LPT infant presents a nutritional challenge to healthcare providers starting immediately following birth when deciding where the appropriate level of care should be provided. Triage of the LPT may vary among hospitals; some infants may be cared for on the postnatal ward, whereas others are admitted to a newborn nursery or NICU.

A survey of admission practices for LPT infants in England showed that the median (range) birth weight and gestational age limits for direct postnatal ward admission were 35 (34–37) weeks and 2 (1.5–2.5) kg, respectively (67). This survey also highlighted that in addition to the large variation of admission criteria among units, these criteria vary according to the type of neonatal units. In a large prospective population-based study constituting births in 4 UK maternity centres, 64% of the LPT infants were never admitted to a neonatal unit (14,18) although most (83%) of those who stayed on the postnatal wards still required some kind of medical input (18). LPT infants have significantly more medical problems and are more likely to require specific medical support including intravenous infusions than term infants (26.7% vs 5.3%; OR: 6.48; 95% CI 2.27–22.91; $P = .0007$) (23), resulting in a significantly longer duration of hospital stay compared with term infants (16,18,68). Furthermore, resource utilization including total parenteral nutrition (PN)/intravenous support (53% vs 17% vs 3%) and length of stay (14 ± 22 vs 4 ± 4.7 vs 2.6 ± 3.9 days) is significantly higher ($P < 0.001$) in MPT infants versus LPT and term infants (9).

Striking variations in nutritional practices for LMPT infants have been documented (69). NICU admission of LMPT infants has been shown to have a positive effect on breast-feeding continuation in some settings (70), a negative effect in some settings (71), and no effect in other settings (72,73). In a very large study including 138,359 term and preterm infants in the United States, the incidence of breast feeding after 4 months was 48% versus 44% in LPT infants admitted versus those not admitted in the NICU and 49% versus 35% in MPT infants (70). This suggests that treating LPT infants as healthy term babies may serve as a disadvantage to this group and that different settings require different solutions. Early rooming-in and breast-feeding support is generally encouraged and adequate care and support should be provided.

Parenteral Nutrition Support

Within the group of LMPT, those born at a lower gestational age are more likely to receive PN/intravenous support than those born at a higher gestational age (9,74,75). The need for central venous access remains a controversial issue in the nutritional care of LMPT infants. In a recent survey including 25 different centres in France, 56% of them had a written protocol stating that PN should be started on the first day of life for MPT infants. (26). In practice, 61% of the MPT infants received a central line during hospitalization (26).

In another observational study, the use of peripherally inserted central catheters in MPT infants improved nutrition delivery and postnatal growth in 187 infants born between 32 and 34 6/7 week gestation (76). Energy and protein intakes were 16% and 36% higher ($P < 0.001$) in the group with central line.

The use of central lines in MPT infants allows delivery of parenteral nutrition with high osmolarity, and thus facilitates adequate nutrient intakes, which in turn may help prevent postnatal growth restriction. On the other hand, use of central lines is associated with risks including sepsis and thrombosis, it is time-consuming, and it requires expertise and admission in units with appropriate resources.

Enteral Nutrition Support

Enteral nutrition support varies from unit to unit. In a retrospective review of medical records of 647 preterm infants from 6 different NICUs including LMPT infants, the median time to the first feed offered was 1 day and the median duration of tube feeding was 12 days but with a very large interquartile range (77). Gestational age, birthweight, medical conditions, and centre were strong predictors of the time to attain full oral feeding (77).

Whether or not combining breast-feeding with supplementary formula feeds to improve growth is beneficial or not in LPT infants remains a matter of debate. Indeed, in the LPT population, those who received regular supplementary formula feeds may experience a longer delay before initiation of breast-feeding, and may have longer hospital stay than infants exclusively breast fed from birth without any evidence of higher weight gain (78).

Observational studies performed in MPT infants show that the average time of initiation of enteral feeding, the advancement of feeding volume, and the rate of human milk fortification varies greatly. On average, breastmilk fortification was provided to 65% of MPT infants studied in France (26). Likewise, there is a range in the type of formula prescribed at discharge for these infants. A study performed in 10 NICUs in the United States showed that being discharged on a postdischarge formula varied from 4% to 72% (69). Because of challenges in establishing successful breast-feeding, formula milk may be used in up to 80% of MPT infants (75). Interestingly, the MPT infants with lowest GAs, received higher nutrient intakes per kilogram, reflecting a greater use of PN and proactive nutritional support (75).

In the randomized controlled study by Zecca et al (27), assessing the efficacy of a proactive feeding regimen in reducing hospital length of stay in MPT infants born small for gestational age, the infants assigned to the proactive feeding regimen ($n = 31$) received significantly less intravenous fluids (2.8% vs 33.3%; $P = .0013$), had less weight loss and significantly faster regain of birth weight, whereas feeding intolerance and faecal calprotectin levels did not differ compared with the controls. As previously described, the proactive group also had a highly significant lower incidence of hypoglycaemia (33.3% vs 0%, $P = 0.0002$), and they were discharged significantly earlier (11.9 ± 4.7 days vs 9.8 ± 3.1 days, $P = 0.029$) (27). This well designed study shows that providing efficient enteral support, may improve weight gain, reduce the need for intravenous fluid and dramatically lower the risk of hypoglycaemia.

These findings support the idea that LMPT infants require specific nutritional regimens.

Breast-feeding Support

Policy statements and practice guidelines support breast-feeding in the LPT population (79). LPT gestation may have a negative effect on mothers' psychological profiles in the puerperium, where levels of anxiety, depression, and psychological distress correlate negatively with early lactation success (80). Mothers of LPT infants recognize that breast-feeding is a bonding experience for themselves and their infants (81,82). They do report, however, that their breast-feeding experiences include challenges with latching and milk supply, inadequate lactation support from providers after discharge and a feeling of failure.

Although breast-feeding initiation in LPT infants has increased over the past decades (73), establishing breast-feeding in these infants is frequently more problematic than in term infants and as a consequence they are less likely to be breast-fed and less likely to breast-feed for a long duration (18,83–87). Because of their immaturity, LPT infants may be sleepier, have less stamina and more difficulty with latch, suck, and swallow. They are more often separated from their mother, who might also have a medical condition affecting the success of breast-feeding (88). Finally, LPT infants are more likely to be born after with caesarean-section, which may adversely affect the onset of lactation and the success of breast-feeding (89).

In a large population-based study performed in 4 large maternity centres in the UK, LPT infants appeared less likely to receive any breast milk during initial hospitalization than term infants or MPT infants (18). These recent data confirm earlier data showing that breast-feeding initiation among LPT infants is around 59% to 75%, which is lower than that observed in term infants (46).

Several reasons and factors including marital status, maternal age, race/ethnicity, education, parity, Women, Infants and Children Program participation, NICU admission, and smoking status have been found to be associated with successful breast-feeding of LPT infants (73). Interestingly, the rate of initiation of breast-feeding of LMPT infants has been described to be lower than that of very preterm infants with the lowest rates for LMPT infants not admitted to a NICU (55.3% vs 70.2%). (70). However, NICU admission may also disrupt the establishment of breast-feeding because of the inability to initiate breast-feeding within 1 hour after birth, separation from their mother, and by the use of infant formula.

Limited data are available for assessing the duration of breast-feeding in the LMPT population. Breast-feeding tends to decrease over the postpartum period, and rates may be less than that for either term or earlier preterm infants at several weeks postpartum (46,90). In the UK population-based study described above, the chance of receiving breast milk at discharge was 18% lower for the LPT infants and 26% lower for the MPT infants compared with the term infants. The chance of being exclusively breast-fed at discharge was also significantly lower (40% and 34%, respectively vs 65%) (46). These data demonstrate the shorter duration of breast-feeding in the LMPT population, and suggest that breast-feeding may only continue for a few days or weeks in many infants. It has been suggested that the higher breast-feeding rates among very preterm as compared with LPT infants may be the result of extra vigilance, breast-feeding support, and importance placed on breast milk feeds in the NICU.

Interestingly, a study of breast-feeding patterns after hospital discharge showed that the proportion of feeds at the breast increased

steadily over the first 4 weeks and that infants who received breast milk exclusively during the first week of life were significantly more likely to be primarily fed directly at the breast at 1 month (91). Perceived inadequate milk supply and nursing difficulties were among the reasons cited by the mothers for discontinuing breast-feeding their LPT infant after discharge (72). Duration of successful breast-feeding tends to be strongly associated with maternal confidence (92) and breast-feeding support should be provided to address these concerns.

The PROBIT cluster randomized trial clearly demonstrated that breast-feeding promotion increases the duration and degree of breast-feeding and also decreases the risk of gastrointestinal tract infection and atopic eczema in the first year of babies born with a birth weight above 2500 g (93). A systematic review confirms that interventions supporting breast-feeding are associated with an increase in the rates of any and exclusively breast-feeding (94). The effect of interventions to promote breast-feeding in the late preterm infant has recently been reviewed (95). Inpatient care practices, such as kangaroo mother care or rooming-in (90,96), early skin-to-skin care (97), and cup feeding (98,99) may improve breast-feeding establishment and duration whereas others, such as expressing breastmilk (96), use of pacifier of nipple shields (90), or use of infant formula (78,97) are some of the common practices that may negatively impact mother's establishment of exclusive breast-feeding of LMPT infants.

Breast-feeding education provided by nurses, peer counsellors, and lactation consultants contribute to earlier initiation of breast-feeding after birth and a higher likelihood of longer breast-feeding after discharge (95). A structured psychoeducative intervention up to 3 months for parents of preterm infants reduced postpartum depression and extended the period of breast-feeding (100). As a high level of in-hospital support is associated with increased exclusive breast-feeding (97), the WHO-Baby-Friendly Hospital Initiative strongly emphasizes the need for supportive practices during hospitalization to promote breast-feeding (101). However, LPT versus term infants are less likely to be exclusively breast-fed and data suggest that hospital supportive practices may be paradoxically less frequent among LPT infants than in term infants (97). For example, LPT infants experience less skin-to-skin contact with their mother in the first hour of life, and they benefit less from rooming-in and/or withholding of a pacifier (97). After discharge from hospital, receiving sufficient help with breast-feeding is also associated with improved breast-feeding in LPT infants (102). Evidence-based recommendations for appropriate discharge timing and postdischarge follow-up for LPT infants have been proposed to prevent neonatal morbidity and readmission (103). The Academy of Breast-feeding Medicine issued guidelines to promote and sustain breast-feeding in the LPT infant (104).

ESTIMATION OF NUTRITIONAL REQUIREMENTS

It is generally accepted that the goal for the nutrition of the preterm infant is to supply nutrients such that the rate of growth and body composition would be equivalent to that of a normal foetus of the same postmenstrual age, without producing metabolic stress. Clinical studies have shown that enteral and parenteral nutrient intakes for very preterm infants that are closer to those estimated to produce growth rates that approximate that of the foetus, reduce the cumulative energy and protein deficits and promote postnatal growth, optimal body composition at discharge, and perhaps even neurodevelopmental outcomes (1,105,106). The 2010 ESPGHAN guidelines for the enteral nutrient supply for preterm infants propose advisable ranges for nutrient intakes for stable-growing preterm infants from 1000 g up to a weight of approximately 1800 g (1). Indeed, most data that are available have been obtained for this weight range, which tends to correspond to ~50% of the MPT infants but does not correspond to many LPT infants.

Nutrient requirements of very preterm infants are estimated by considering intrauterine accretion rates, organ development, factorial estimates of requirements, nutrient interactions, and supplemental feeding studies. Nutritional requirements of normal birth weight term infants are based on the average intake and nutrient content of breast milk. Nutrient requirements per kilogram body weight of LMPT infants are likely somewhere between those of very preterm infants and term infants. The exact nutrient requirements of LMPT infants are, however, not known. It is likely that the nutrient requirements of LPT infants will be higher than those of term infants but may be provided by unsupplemented breast milk, especially if the infant is capable of upregulating feeding volumes to cover needs. However, the nutrient requirements of MPT infants are likely to be closer to those of very preterm infants and the most immature MPT infants and those with a birth weight <1800 g will need supplements in addition to breast milk to comply the 2010 ESPGHAN recommendations (1).

Resting energy expenditure (REE) is approximately 45 $kcal \cdot kg^{-1} \cdot day^{-1}$ in very preterm infants and 50 $kcal \cdot kg^{-1} \cdot day^{-1}$ in less preterm infants. Additional energy expenditure for occasional thermal stress and physical activity (movement, crying) increases from 15 in very preterm infants to 20 $kcal \cdot kg^{-1} \cdot day^{-1}$ in less preterm infants. During gestation, fat mass deposition as a proportion of weight gain increases from 12% at 28 weeks GA to 20% at term and reaches 40% in breast-fed term infants (107). Foetal energy deposition per gram of weight gain also increases from 1.8 kcal/g at 28 weeks GA to 2.3 kcal/g at term and represents 3.8 kcal/g in breast-fed term infants. Therefore, energy requirements vary only slightly across all preterm groups. One study, which specifically assessed total energy expenditure (TEE) in MPT infants at corrected term age, showed that TEE was on average 75 $kcal \cdot kg^{-1} \cdot day^{-1}$ and 23% higher than that of term infants (40). In another study using indirect calorimetry, REE in SGA MPT infants was significantly higher than that of AGA MPT infants (108). These studies provide evidence that energy requirements of MPT infants is higher than that of term infants, and that those born SGA have significantly higher energy needs than those born AGA. Overall, the higher TEE per kilogram body weight in MPT infants can be explained by a higher growth rate. Postnatally, energy intake per kilogram body weight is linearly associated with weight gain during the first 28 days of life in LMPT infants (109).

Foetal weight gain decreases dramatically during the last trimester of gestation from 18 to 20 $g \cdot kg^{-1} \cdot day^{-1}$ at 28 weeks GA to 10 $g \cdot kg^{-1} \cdot day^{-1}$ in term infants (110,111). Protein accretion, and therefore, requirement related to body weight, decreases progressively according to gestational age during the last trimester of gestation up to the values estimated for term infants. There is no study assessing protein requirements in LMPT infants.

Among other nutritional factors that affect early infant development or visual acuity, long-chain polyunsaturated fatty acids (LCPUFAs) have been recognized to be particularly important in the very preterm population (112). Very little is known about the importance of these fatty acids in the LMPT population. At birth, a significant correlation exists between gestational age and circulating docosahexaenoic acid (DHA) and arachidonic acid (AA) levels. In turn, a 30% lower DHA level is observed in MPT infants compared with term infants (113). One study performed in Taiwan aimed to specifically assess the effects of a 6-month postnatal intervention on visual acuity and cognitive development in MPT infants (ie, 30–37 weeks GA) (114). This study suggests possible benefits on neurodevelopment at 1 year of a formula supplementation with both DHA and AA. DHA and AA requirements in LMPT

are likely to be higher than term infants but there is insufficient data to recommend precise intakes.

Because of shorter duration of pregnancy and lower birthweights, LMPT infants have lower iron stores at birth than term infants (115), particularly those born SGA or from a diabetic mother (116). In the latter study, the LPT infants with serum ferritin concentrations below 75 ng/mL exhibited abnormal auditory neural maturation within the first 48 hours of life (116). In contrast, other LMPT infants may have higher iron stores during their first weeks of life because of delayed cord clamping or cord milking (117). Several studies have described that LMPT infants are at risk of early iron deficiency (ID) and iron-deficiency anaemia (IDA). In a case-control study performed in Turkey, the mean ferritin and haemoglobin concentrations of LPT infants were statistically lower than those of term infants at 2 months of age but not at 4 months (118). In a cohort study in Brazil, LPT infants had a decline in haemoglobin concentration but similar ferritin concentrations as term infants at the same postconceptional age of 1 month (119). In a prospective longitudinal study performed in Greece, formula-fed LMPT infants exhibited progressive decline of blood ferritin concentration during the first year of life to reach a mean value $\pm$ SD of 20 ± 9 ng/mL at 12 months of age, with lower values more commonly observed in the children of lower gestational ages (120). In a prospective cohort of 161 Dutch infants born LMPT, ID was present in 21% and IDA in 8.5% of the infants at age 4 months. In another observational study performed in the Netherlands, ID and IDA were found to be common and present in 38.2% and 30.9% of the LMPT infants ages 6 weeks who did not receive iron supplementation on a routine basis (121). The rate of ID decreased with increased postnatal age to 18.9% at 4 months and 5% at 6 months (122). The risk for ID was significantly associated with lower birth weight, a shorter duration of formula feeding, more weight gain in the first 6 months of life and lower ferritin concentrations at the age of 1 week (122). There is evidence from a Swedish randomized controlled trial performed in a mixed group of LMPT infants and SGA term infants that iron supplementation reduces the risk of ID at 6 months (123) and 1 year but not at 3.5 years (124). Iron supplementation independently lowered systolic BP at age 7 (125), reduced the risk of behavioural problems at 3.5 and 7 years of age (126,127) but did not alter auditory brainstem response (128). This study, however, did not observe different effects of iron supplementation in LMPT infants as compared with small for gestational age term infants.

Nutritional stores of essential nutrients of newborn infants depend on transplacental transfer and are related to gestational age as illustrated above for LC-PUFAs and iron. The nutritional requirements of LMPT for calcium, phosphorus, vitamins, and trace elements are likely to be higher than those for term infants but there are insufficient data to recommend precise intake as our systematic review did neither identify observational nor randomized controlled trials assessing the nutritional needs of LMPT infants for those nutrients except vitamin D. A vitamin D intake of 800 to 1000 IU/day (and not per kilogram) during hospitalization has been recommended by the ESPGHAN committee on Nutrition for the very preterm infants (1). A study performed in Korea showed that in both MPT and LPT infants, the incidence of vitamin D deficiency was very high and that half of the infants had severe deficiency defined by a circulating 25 hydroxyvitamin D below 10 ng/mL (129). In this study, the risk of vitamin D deficiency was not associated with lower gestational age but was associated with twin pregnancy and seasonal variation. Another study performed in LPT infants demonstrated that even in a sunny country like Greece, the circulating levels of 25 hydroxyvitamin D is low during the first 3 months of life (130). This suggests that vitamin D supplementation is also required from birth in LMPT infants. A study performed in Canada showed that the chance of receiving vitamin supplementation after discharge is lower in the LPT population than in preterm infants born before 34 weeks of gestation (131). Targeting LPT infants could improve vitamin D intake in these infants who are at high risk of vitamin deficiency. Further studies are nevertheless needed to confirm whether higher vitamin D intakes (ie, 800–1000 IU/day) are needed or if 400 IU/day is sufficient.

CONCLUSIONS

1. Compared with term infants, LPT infants require specific management because they have unique, often unrecognized, medical vulnerabilities that predispose them to high rates of morbidity and hospital readmissions.
2. LPT infants frequently have lower rates of breast-feeding initiation, take longer to establish breast-feeding, and have shorter breast-feeding duration than term infants. Breast-feeding support through maternal education, kangaroo care, rooming-in, skin to skin care and postdischarge support, is associated with improved breast-feeding initiation and duration in LPT infants.
3. Similar to very preterm infants, lack of breast-feeding at discharge in LMPT infants is associated with worse cognitive and behavioral outcomes.
4. MPT infants are prone to develop postnatal growth restriction and transient altered body composition. Children and young adults born LMPT have a higher risk of lower weight and height during childhood, insulin resistance, glucose intolerance, and high blood pressure than those born at term, but there is a lack of data on the effects of early nutrition during hospitalization or after discharge on these outcomes.
5. LMPT infants are at high risk of hypoglycemia. The use of proactive nutritional support for high-risk infants is effective in preventing hypoglycemia.
6. There is a lack of data for determining precise nutritional requirements in LMPT infants. In the LMPT population, the need for active nutritional support is strongly correlated with gestational age. There are insufficient data to make precise recommendations for the use of parenteral nutrition, human milk fortifier, preterm formula, or nutritional supplements. A subgroup of MPT infants may benefit from more active enteral and parenteral nutrition support to promote growth, even though the long-term benefits of such an approach have not been evaluated.

RECOMMENDATIONS

Based on the above conclusions and considering current practice, the ESPGHAN CoN makes the following recommendations:

1. Hospitals should have their own policies to prevent and treat the known complications associated with LMPT birth, particularly early hypoglycemia. Early rooming-in is encouraged and proactive nutritional care and support should be provided.
2. Breast-feeding for LMPT infants is strongly endorsed. Mothers of LMPT preterm infants should receive qualified, extended lactation support, and frequent follow-up.
3. Health care providers should remain vigilant for evidence of poor breast milk transfer and infant problems related to poor intake. Individualized feeding plans should be promoted and should include special considerations to compensate for immature feeding skills and difficulties in establishing lactation and breast-feeding.

4. Individual discharge plans should be developed in every hospital taking into account local situation and resources. Delayed hospital discharge should be considered if the LMPT infant does not fulfill the requirements of a safe discharge plan.
5. LMPT infants with birthweight less than 1800 g should receive enteral nutrient supply as previously described by the ESPGHAN CoN (1).
6. The use of human milk fortifier, enriched formula and/or additional supplements, and parenteral nutrition may be appropriate for some LMPT infants taking into account factors, such as gestational age, birth weight, and significant comorbidities.
7. LMPT infants are at risk of iron deficiency, which may impair neurodevelopment. LMPT infants weighing less than 2500 g at birth should receive 1 to 2 $mg\,kg^{-1}\cdot day^{-1}$ of iron up to 6 months age. LMPT infants weighing less than 2000 g should receive 2 to 3 $mg\,kg^{-1}\cdot day^{-1}$ of iron at least up to 6 months.
8. LMPT infants require a daily vitamin D supplement of at least 400 IU/day throughout early childhood.

RESEARCH GAPS

1. Further research is needed to better understand how breast-feeding rates can be improved in LMPT infants.
2. Current nutritional practices provided to LMPT infants may result in transient undernutrition but its magnitude and consequences are not well known. Research on the effects of early nutrition on long-term outcomes (eg, neurological, developmental, metabolic, and cardiovascular) of LMPT infants is required.
3. Benefits (growth, improved development) versus risks (interruption of breast-feeding, complications associated with parenteral nutrition, cardiovascular and metabolic outcomes) of providing nutrient-enriched feeds to the LMPT infant are not well determined. Research in this area is strongly encouraged as they represent the largest group of preterm infants.
4. Further research is needed to determine whether nutritional requirements are mainly dependent on gestational age or birth weight in preterm infants.

REFERENCES

1. Agostoni C, Buonocore G, Carnielli VP, et al., ESPGHAN Committee on Nutrition. Enteral nutrient supply for preterm infants: commentary from the European Society of Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. *J Pediatr Gastroenterol Nutr* 2010;50:85–91.
2. EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies), 2013. Scientific Opinion on nutrient requirements and dietary intakes of infants and young children in the European Union. *EFSA J* 2013;11:3408.
3. Raju TN, Higgins RD, Stark AR, et al. Optimizing care and outcome for late-preterm (near-term) infants: a summary of the workshop sponsored by the National Institute of Child Health and Human Development. *Pediatrics* 2006;118:1207–14.
4. Mericq V, Martinez-Aguayo A, Uauy R, et al. Long-term metabolic risk among children born premature or small for gestational age. *Nat Rev Endocrinol* 2017;13:50–62.
5. Beck S, Wojdyla D, Say L, et al. The worldwide incidence of preterm birth: a WHO systematic review of maternal mortality and morbidity. *Bull Word Health Organ* 2010;88:31–8.
6. National Vital Statistics Reports. National Center for Health Statistics 2010. Available at: *http://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_01.pdf.*
7. Richards JL, Kramer MS, Deb-Rinker P, et al. Temporal trends in late preterm and early term birth rates in 6 high-income countries in North America and Europe and Association With clinician-initiated obstetric interventions. *JAMA* 2016;316:410–9.
8. DRESS Ia. Enquête nationale périnatale, Rapport 2016. Available at: www.epopé-inserm.fr/wp-content/uploads/2017/10/ENP2016_rapport_complet.pdf.
9. Visruthan NK, Agarwal P, Sriram B, et al. Neonatal outcome of the late preterm infant (34 to 36 weeks): the Singapore Story. *Ann Acad Med Singapore* 2015;44:235–43.
10. Kirkby S, Greenspan JS, Kornhauser M, et al. Clinical outcomes and cost of the moderately preterm infant. *Adv Neonatal Care* 2007;7:80–7.
11. Raju TN. Epidemiology of late preterm (near-term) births. *Clin Perinatol* 2006;33:751–63.
12. Altman M, Vanpee M, Cnattingius S, et al. Neonatal morbidity in moderately preterm infants: a Swedish national population-based study. *J Pediatr* 2011;158:239.e1–44.e1.
13. Engle WA, Tomashek KM, Wallman C. "Late-preterm" infants: a population at risk. *Pediatrics* 2007;120:1390–401.
14. Celik IH, Demirel G, Canpolat FE, et al. A common problem for neonatal intensive care units: late preterm infants, a prospective study with term controls in a large perinatal center. *J Matern Fetal Neonatal Med* 2013;26:459–62.
15. Kalyoncu O, Aygun C, Cetinoglu E, et al. Neonatal morbidity and mortality of late-preterm babies. *J Matern Fetal Neonatal Med* 2010;23:607–12.
16. Pulver LS, Denney JM, Silver RM, et al. Morbidity and discharge timing of late preterm newborns. *Clin Pediatr (Phila)* 2010;49:1061–7.
17. Escobar GJ, McCormick MC, Zupancic JA, et al. Unstudied infants: outcomes of moderately premature infants in the neonatal intensive care unit. *Arch Dis Child Fetal Neonatal Ed* 2006;91:F238–44.
18. Boyle EM, Johnson S, Manktelow B, et al. Neonatal outcomes and delivery of care for infants born late preterm or moderately preterm: a prospective population-based study. *Arch Dis Child Fetal Neonatal Ed* 2015;100:F479–85.
19. Brown AK, Damus K, Kim MH, et al. Factors relating to readmission of term and near-term neonates in the first two weeks of life. Early Discharge Survey Group of the Health Professional Advisory Board of the Greater New York Chapter of the March of Dimes. *J Perinat Med* 1999;27:263–75.
20. Tomashek KM, Shapiro-Mendoza CK, Weiss J, et al. Early discharge among late preterm and term newborns and risk of neonatal morbidity. *Semin Perinatol* 2006;30:61–8.
21. Kuzniewicz MW, Parker SJ, Schnake-Mahl A, et al. Hospital readmissions and emergency department visits in moderate preterm, late preterm, and early term infants. *Clin Perinatol* 2013;40:753–75.
22. Hosagasi NH, Aydin M, Zenciroglu A, et al. Incidence of hypoglycemia in newborns at risk and an audit of the 2011 American academy of pediatrics guideline for hypoglycemia. *Pediatr Neonatol* 2017;59:368–74.
23. Wang ML, Dorer DJ, Fleming MP, et al. Clinical outcomes of near-term infants. *Pediatrics* 2004;114:372–6.
24. Garg M, Devaskar SU. Glucose metabolism in the late preterm infant. *Clin Perinatol* 2006;33:853–70.
25. Stewart B, Karahalios A, Pszczola R, et al. Moderate to late preterm intrauterine growth restriction: a restrospective, observational study of the indications for delivery and outcomes in an Australian perinatal centre. *Aust N Z J Obstet Gynaecol* 2018;58:306–14.
26. Iacobelli S, Viaud M, Lapillonne A, et al. Nutrition practice, compliance to guidelines and postnatal growth in moderately premature babies: the NUTRIQUAL French survey. *BMC Pediatr* 2015;15:110.
27. Zecca E, Costa S, Barone G, et al. Proactive enteral nutrition in moderately preterm small for gestational age infants: a randomized clinical trial. *J Pediatr* 2014;165:1135.e1–9e.
28. Medoff Cooper B, Holditch-Davis D, Verklan MT, et al. Newborn clinical outcomes of the AWHONN late preterm infant research-based practice project. *J Obstet Gynecol Neonatal Nurs* 2012;41:774–85.
29. Santos IS, Matijasevich A, Domingues MR, et al. Late preterm birth is a risk factor for growth faltering in early childhood: a cohort study. *BMC Pediatr* 2009;9:71.
30. Goyal NK, Fiks AG, Lorch SA. Persistence of underweight status among late preterm infants. *Arch Pediatr Adolesc Med* 2012;166:424–30.
31. Gong YH, Ji CY, Shan JP. A longitudinal study on the catch-up growth of preterm and term infants of low, appropriate, and high birth weight. *Asia Pac J Public Health* 2015;27:N1421–3.

32. Zhao Z, Ding M, Hu Z, et al. Trajectories of length, weight, and bone mineral density among preterm infants during the first 12 months of corrected age in China. *BMC Pediatr* 2015;15:91.
33. Boyle EM, Poulsen G, Field DJ, et al. Effects of gestational age at birth on health outcomes at 3 and 5 years of age: population based cohort study. *BMJ* 2012;344:e896.
34. Blackwell MT, Eichenwald EC, McAlmon K, et al. Interneonatal intensive care unit variation in growth rates and feeding practices in healthy moderately premature infants. *J Perinatol* 2005;25:478–85.
35. Bocca-Tjeertes IF, Kerstjens JM, Reijneveld SA, et al. Growth and predictors of growth restraint in moderately preterm children aged 0 to 4 years. *Pediatrics* 2011;128:e1187–94.
36. Dotinga BM, Eshuis MS, Bocca-Tjeertes IF, et al. Longitudinal growth and neuropsychological functioning at age 7 in moderate and late preterms. *Pediatrics* 2016;138:.
37. Bocca-Tjeertes I, Bos A, Kerstjens J, et al. Symmetrical and asymmetrical growth restriction in preterm-born children. *Pediatrics* 2014;133:e650–6.
38. Bocca-Tjeertes IF, Kerstjens JM, Reijneveld SA, et al. Growth patterns of large for gestational age children up to age 4 years. *Pediatrics* 2014;133:e643–9.
39. Nagasaka M, Morioka I, Yokota T, et al. Incidence of short stature at 3 years of age in late preterm infants: a population-based study. *Arch Dis Child* 2015;100:250–4.
40. Olhager E, Forsum E. Total energy expenditure, body composition and weight gain in moderately preterm and full-term infants at term postconceptional age. *Acta Paediatr* 2003;92:1327–34.
41. Gianni ML, Roggero P, Liotto N, et al. Postnatal catch-up fat after late preterm birth. *Pediatr Res* 2012;72:637–40.
42. Liotto N, Gianni ML, Taroni F, et al. Is fat mass accretion of late preterm infants associated with insulin resistance? *Neonatology* 2017;111:353–9.
43. Gianni ML, Consonni D, Liotto N, et al. Does human milk modulate body composition in late preterm infants at term-corrected age? *Nutrients* 2016;8:pii: E664.
44. Gianni ML, Roggero P, Liotto N, et al. Body composition in late preterm infants according to percentile at birth. *Pediatr Res* 2016;79:710–5.
45. Olhager E, Tornqvist C. Body composition in late preterm infants in the first 10 days of life and at full term. *Acta Paediatr* 2014;103:737–43.
46. Radtke JV. The paradox of breastfeeding-associated morbidity among late preterm infants. *J Obstet Gynecol Neonatal Nurs* 2011;40:9–24.
47. Neu J. Gastrointestinal maturation and feeding. *Semin Perinatol* 2006;30:77–80.
48. ABM Clinical Protocol #10: breastfeeding the late preterm infant (34(0/7) to 36(6/7) Weeks Gestation) (First Revision June 2011) (*). *Breastfeed Med* 2011;6:151–6.
49. DeMauro SB, Patel PR, Medoff-Cooper B, et al. Postdischarge feeding patterns in early- and late-preterm infants. *Clin Pediatr (Phila)* 2011;50:957–62.
50. Johnson S, Matthews R, Draper ES, et al. Eating difficulties in children born late and moderately preterm at 2 y of age: a prospective population-based cohort study. *Am J Clin Nutr* 2016;103:406–14.
51. Roswall J, Karlsson AK, Allvin K, et al. Preschool children born moderately preterm have increased waist circumference at two years of age despite low body mass index. *Acta Paediatr* 2012;101:1175–81.
52. Lindberg J, Norman M, Westrup B, et al. Overweight, obesity, and body composition in 3.5- and 7-year-old Swedish children born with marginally low birth weight. *J Pediatr* 2015;167:1246.e3–52.e3.
53. Johansson S, Iliadou A, Bergvall N, et al. Risk of high blood pressure among young men increases with the degree of immaturity at birth. *Circulation* 2005;112:3430–6.
54. Dalziel SR, Parag V, Rodgers A, et al. Cardiovascular risk factors at age 30 following pre-term birth. *Int J Epidemiol* 2007;36:907–15.
55. Mathai S, Derraik JG, Cutfield WS, et al. Blood pressure abnormalities in adults born moderately preterm and their children. *Int J Cardiol* 2015;181:152–4.
56. Lapillonne A, Griffin IJ. Feeding preterm infants today for later metabolic and cardiovascular outcomes. *J Pediatr* 2013;162(3 Suppl):S7–16.
57. Mathai S, Cutfield WS, Derraik JG, et al. Insulin sensitivity and beta-cell function in adults born preterm and their children. *Diabetes* 2012;61:2479–83.
58. Mathai S, Derraik JG, Cutfield WS, et al. Increased adiposity in adults born preterm and their children. *PLoS One* 2013;8:e81840.
59. Ghaemi S, Najafi R, Kelishadi R. Cord blood lipoprotein profile in term, preterm, and late preterm newborns. *J Res Med Sci* 2014;19:1038–40.
60. Nagano N, Okada T, Yonezawa R, et al. Early postnatal changes of lipoprotein subclass profile in late preterm infants. *Clin Chim Acta* 2012;413:109–12.
61. Dalziel SR, Fenwick S, Cundy T, et al. Peak bone mass after exposure to antenatal betamethasone and prematurity: follow-up of a randomized controlled trial. *J Bone Miner Res* 2006;21:1175–86.
62. McGowan JE, Alderdice FA, Holmes VA, et al. Early childhood development of late-preterm infants: a systematic review. *Pediatrics* 2011;127:1111–24.
63. Baraton L, Ancel PY, Flamant C, et al. Impact of changes in serum sodium levels on 2-year neurologic outcomes for very preterm neonates. *Pediatrics* 2009;124:e655–61.
64. Escobar GJ, Liljestrand P, Hudes ES, et al. Five-year neurodevelopmental outcome of neonatal dehydration. *J Pediatr* 2007;151:127–33133.e1.
65. McGowan JE, Alderdice FA, Doran J, et al. Impact of neonatal intensive care on late preterm infants: developmental outcomes at 3 years. *Pediatrics* 2012;130:e1105–12.
66. Johnson S, Evans TA, Draper ES, et al. Neurodevelopmental outcomes following late and moderate prematurity: a population-based cohort study. *Arch Dis Child Fetal Neonatal Ed* 2015;100:F301–8.
67. Fleming PF, Arora P, Mitting R, et al. A national survey of admission practices for late preterm infants in England. *BMC Pediatr* 2014;14:150.
68. Khashu M, Narayanan M, Bhargava S, et al. Perinatal outcomes associated with preterm birth at 33 to 36 weeks' gestation: a population-based cohort study. *Pediatrics* 2009;123:109–13.
69. McCormick MC, Escobar GJ, Zheng Z, et al. Place of birth and variations in management of late preterm (''near-term'') infants. *Semin Perinatol* 2006;30:44–7.
70. Colaizy TT, Morriss FH. Positive effect of NICU admission on breastfeeding of preterm US infants in 2000 to 2003. *J Perinatol* 2008;28:505–10.
71. Hannan KE, Juhl AL, Hwang SS. Impact of NICU admission on Colorado-born late preterm infants: breastfeeding initiation, continuation and in-hospital breastfeeding practices. *J Perinatol* 2018;38:557–66.
72. Kair LR, Colaizy TT. Breastfeeding continuation among late preterm infants: barriers, facilitators, and any association with NICU admission? *Hosp Pediatr* 2016;6:261–8.
73. Demirci JR, Sereika SM, Bogen D. Prevalence and predictors of early breastfeeding among late preterm mother-infant dyads. *Breastfeed Med* 2013;8:277–85.
74. Gianni ML, Roggero P, Piemontese P, et al. Is nutritional support needed in late preterm infants? *BMC Pediatr* 2015;15:194.
75. Brown K, Johnson MJ, Leaf AA. Suboptimal nutrition in moderately preterm infants. *Acta Paediatr* 2014;103:e510–2.
76. Smazal AL, Kavars AB, Carlson SJ, et al. Peripherally inserted central catheters optimize nutrient intake in moderately preterm infants. *Pediatr Res* 2016;80:185–9.
77. Jackson BN, Kelly BN, McCann CM, et al. Predictors of the time to attain full oral feeding in late preterm infants. *Acta Paediatr* 2016;105:e1–6.
78. Mattsson E, Funkquist EL, Wickstrom M, et al. Healthy late preterm infants and supplementary artificial milk feeds: effects on breast feeding and associated clinical parameters. *Midwifery* 2015;31:426–31.
79. Briere CE, Lucas R, McGrath JM, et al. Establishing breastfeeding with the late preterm infant in the NICU. *J Obstet Gynecol Neonatal Nurs* 2015;44:102–13.
80. Zanardo V, Gambina I, Begley C, et al. Psychological distress and early lactation performance in mothers of late preterm infants. *Early Hum Dev* 2011;87:321–3.
81. Kair LR, Flaherman VJ, Newby KA, et al. The experience of breastfeeding the late preterm infant: a qualitative study. *Breastfeed Med* 2015;10:102–6.

82. Tully KP, Holditch-Davis D, Silva S, et al. The relationship between infant feeding outcomes and maternal emotional well-being among mothers of late preterm and term infants: a secondary, exploratory analysis. *Adv Neonatal Care* 2017;17:65–75.
83. Ayton J, Hansen E, Quinn S, et al. Factors associated with initiation and exclusive breastfeeding at hospital discharge: late preterm compared to 37 week gestation mother and infant cohort. *Int Breastfeed J* 2012;7:16.
84. Hwang SS, Barfield WD, Smith RA, et al. Discharge timing, outpatient follow-up, and home care of late-preterm and early-term infants. *Pediatrics* 2013;132:101–8.
85. Donath SM, Amir LH. Effect of gestation on initiation and duration of breastfeeding. *Arch Dis Child Fetal Neonatal Ed* 2008;93:F448–50.
86. Hackman NM, Alligood-Percoco N, Martin A, et al. Reduced breastfeeding rates in firstborn late preterm and early term infants. *Breastfeed Med* 2016;11:119–25.
87. Hwang SS, Lu E, Cui X, et al. Home care practices for preterm and term infants after hospital discharge in Massachusetts, 2007 to 2010. *J Perinatol* 2015;35:880–4.
88. Adamkin DH. Feeding problems in the late preterm infant. *Clin Perinatol* 2006;33:831–7.
89. Shapiro-Mendoza CK, Tomashek KM, Kotelchuck M, et al. Effect of late-preterm birth and maternal medical conditions on newborn morbidity risk. *Pediatrics* 2008;121:e223–32.
90. Maastrup R, Hansen BM, Kronborg H, et al. Factors associated with exclusive breastfeeding of preterm infants. Results from a prospective national cohort study. *PLoS One* 2014;9:e89077.
91. Wooldridge J, Hall WA. Posthospitalization breastfeeding patterns of moderately preterm infants. *J Perinat Neonatal Nurs* 2003;17:50–64.
92. Gerhardsson E, Hildingsson I, Mattsson E, et al. Prospective questionnaire study showed that higher self-efficacy predicted longer exclusive breastfeeding by the mothers of late preterm infants. *Acta Paediatr* 2018;107:799–805.
93. Kramer MS, Chalmers B, Hodnett ED, et al. Promotion of Breastfeeding Intervention Trial (PROBIT): a randomized trial in the Republic of Belarus. *JAMA* 2001;285:413–20.
94. Patnode CD, Henninger ML, Senger CA, et al. Primary care interventions to support breastfeeding: updated evidence report and systematic review for the US Preventive Services Task Force. *JAMA* 2016;316:1694–705.
95. Cartwright J, Atz T, Newman S, et al. An Integrative Review of Interventions to Promote Breastfeeding in the Late Preterm Infant. *J Obstet Gynecol Neonatal Nurs* 2017;46:347–56.
96. Gianni ML, Bezze E, Sannino P, et al. Facilitators and barriers of breastfeeding late preterm infants according to mothers' experiences. *BMC Pediatr* 2016;16:179.
97. Goyal NK, Attanasio LB, Kozhimannil KB. Hospital care and early breastfeeding outcomes among late preterm, early-term, and term infants. *Birth* 2014;41:330–8.
98. Flint A, New K, Davies MW. Cup feeding versus other forms of supplemental enteral feeding for newborn infants unable to fully breastfeed. *Cochrane Database Syst Rev* 2016;5:CD005092.
99. Yilmaz G, Caylan N, Karacan CD, et al. Effect of cup feeding and bottle feeding on breastfeeding in late preterm infants: a randomized controlled study. *J Hum Lact* 2014;30:174–9.
100. Ravn IH, Smith L, Smeby NA, et al. Effects of early mother-infant intervention on outcomes in mothers and moderately and late preterm infants at age 1 year: a randomized controlled trial. *Infant Behav Dev* 2012;35:36–47.
101. Organization WH. World Health Organization; Baby-friendly Hospital Initiative. Available at: *http://www.who.int/nutrition/topics/bfhi/en/*.
102. Rayfield S, Oakley L, Quigley MA. Association between breastfeeding support and breastfeeding rates in the UK: a comparison of late preterm and term infants. *BMJ Open* 2015;5:e009144.
103. Whyte R. Safe discharge of the late preterm infant. *Paediatr Child Health* 2010;15:655–66.
104. Boies EG, Vaucher YE. ABM Clinical Protocol #10: breastfeeding the late preterm (34-36 6/7 weeks of gestation) and early term infants (37-38 6/7 weeks of gestation), second revision 2016. *Breastfeed Med* 2016;11:494–500.
105. Klein CJ. Nutrient requirements for preterm infant formulas. *J Nutr* 2002;132(6 Suppl 1):1395S–577S.
106. Lapillonne A, O'Connor DL, Wang D, et al. Nutritional recommendations for the late-preterm infant and the preterm infant after hospital discharge. *J Pediatr* 2013;162(3 Suppl):S90–100.
107. Leitch CA, Denne SC. Energy. In: Tsang RC, Uauy R, Koletzko B, Zlotkin SH, eds. *Nutrition of the Preterm Infant. Scientific Basis and Practical Guidelines.* Cincinnati, Ohio: Digital Educational Publishing; 2005:23–44.
108. Bauer J, Masin M, Brodner K. Resting energy expenditure and metabolic parameters in small for gestational age moderately preterm infants. *Horm Res Paediatr* 2011;76:202–7.
109. Yagasaki H, Murakami Y, Ohyama T, et al. Total energy intake accounts for postnatal anthropometric growth in moderately/late preterm infants. *J Matern Fetal Neonatal Med* 2017;30:1080–4.
110. Rigo J. Protein, amino acid and other nitrogen compounds. In: Tsang RC, Uauy R, Koletzko B, Zlotkin SH, eds. *Nutrition of the Preterm Infant. Scientific Basis and Practical Aspects.* Cincinnati, Ohio: Digital Educational Publishing; 2005:45–80.
111. Ziegler EE. Protein requirements of very low birth weight infants. *J Pediatr Gastroenterol Nutr* 2007;45(Suppl 3):S170–4.
112. Lapillonne A, Groh-Wargo S, Gonzalez CH, et al. Lipid needs of preterm infants: updated recommendations. *J Pediatr* 2013;162(3 Suppl):S37–47.
113. Baack ML, Puumala SE, Messier SE, et al. What is the relationship between gestational age and docosahexaenoic acid (DHA) and arachidonic acid (ARA) levels? *Prostaglandins Leukot Essent Fatty Acids* 2015;100:5–11.
114. Fang PC, Kuo HK, Huang CB, et al. The effect of supplementation of docosahexaenoic acid and arachidonic acid on visual acuity and neurodevelopment in larger preterm infants. *Chang Gung Med J* 2005;28:708–15.
115. Bothwell TH. Iron requirements in pregnancy and strategies to meet them. *Am J Clin Nutr* 2000;72(1 Suppl):257S–S264.
116. Choudhury V, Amin SB, Agarwal A, et al. Latent iron deficiency at birth influences auditory neural maturation in late preterm and term infants. *Am J Clin Nutr* 2015;102:1030–4.
117. Mercer JS, Erickson-Owens DA. Placental transfusion improves iron stores at 6 weeks of age in late preterm infants. *Indian Pediatr* 2015;52:747–8.
118. Ozdemir H, Akman I, Demirel U, et al. Iron deficiency anemia in late-preterm infants. *Turk J Pediatr* 2013;55:500–5.
119. Yamada RT, Leone CR. Hematological and iron content evolution in exclusively breastfed late-preterm newborns. *Clinics (Sao Paulo)* 2014;69:792–8.
120. Schiza V, Giapros V, Pantou K, et al. Serum transferrin receptor, ferritin, and reticulocyte maturity indices during the first year of life in 'large' preterm infants. *Eur J Haematol* 2007;79:439–46.
121. Akkermans MD, Uijterschout L, Abbink M, et al. Predictive factors of iron depletion in late preterm infants at the postnatal age of 6 weeks. *Eur J Clin Nutr* 2016;70:941–6.
122. Uijterschout L, Domellof M, Abbink M, et al. Iron deficiency in the first 6 months of age in infants born between 32 and 37 weeks of gestational age. *Eur J Clin Nutr* 2015;69:598–602.
123. Berglund S, Westrup B, Domellof M. Iron supplements reduce the risk of iron deficiency anemia in marginally low birth weight infants. *Pediatrics* 2010;126:e874–83.
124. Berglund SK, Westrup B, Domellof M. Iron supplementation until 6 months protects marginally low-birth-weight infants from iron deficiency during their first year of life. *J Pediatr Gastroenterol Nutr* 2015;60:390–5.
125. Lindberg J, Norman M, Westrup B, et al. Lower systolic blood pressure at age 7 y in low-birth-weight children who received iron supplements in infancy: results from a randomized controlled trial. *Am J Clin Nutr* 2017;106:475–80.
126. Berglund SK, Westrup B, Hagglof B, et al. Effects of iron supplementation of LBW infants on cognition and behavior at 3 years. *Pediatrics* 2013;131:47–55.
127. Berglund SK, Chmielewska A, Starnberg J, et al. Effects of iron supplementation of low-birth-weight infants on cognition and behavior at 7 years: a randomized controlled trial. *Pediatr Res* 2018; 83:111–8.
128. Berglund SK, Westrup B, Haraldsson E, et al. Effects of iron supplementation on auditory brainstem response in marginally LBW infants. *Pediatr Res* 2011;70:601–6.

129. Park SH, Lee GM, Moon JE, et al. Severe vitamin D deficiency in preterm infants: maternal and neonatal clinical features. *Korean J Pediatr* 2015;58:427–33.
130. Giapros VI, Schiza V, Challa AS, et al. Vitamin D and parathormone levels of late-preterm formula fed infants during the first year of life. *Eur J Clin Nutr* 2012;66:224–30.
131. Fatani T, Sharma AK, Weiler HA, et al. Differential low uptake of free vitamin D supplements in preterm infants: the Quebec experience. *BMC Pediatr* 2014;14:291.

APPENDIX 1

The searches were limited to human studies. Literature search terms included firstly those related to the definition of the population studied, restricting the search to words in the title or abstract of the manuscript (Late preterm infant[TIAB] OR Late preterm infants[TIAB] OR Late preterm newborn[TIAB] OR Late preterm newborns[TIAB] OR moderately preterm infants[TIAB] OR moderately preterm infant[TIAB] OR moderately preterm newborn[TIAB] OR moderately preterm newborns[TIAB] OR marginally preterm infant[TIAB] OR marginally preterm infants[TIAB] OR marginally preterm newborn[TIAB] OR marginally preterm newborns[TIAB] OR Larger preterm infant [TIAB] OR Larger preterm infants [TIAB] OR near term infant [TIAB] OR near-term infant [TIAB] OR near term infants [TIAB] OR near-term infants [TIAB]). These were combined, as appropriate, with MeSH terms and keywords relating to nutrition, breast-feeding, and growth (growth OR nutrition OR breast-feeding OR breastmilk OR nutrient OR nutrients OR lipid OR lipids OR protein OR proteins OR enteral nutrition OR parenteral nutrition OR glucose OR iron OR minerals OR calcium OR phosphorus OR zinc OR sodium OR potassium OR trace elements OR vitamin OR vitamins). Among the 498 manuscripts retrieved, 54 were selected for this review based on the reading of titles and abstracts. Furthermore, the reference list from all relevant articles was also searched to complete this review.