Interventions to Improve Breastfeeding Outcomes in Late Preterm and Early Term Infants

Dib S[1,*], Kittisakmontri K[1,2], Wells JC[1], Fewtrell M[1]

1. UCL Great Ormond Street Institute of Child Health, London WC1N 1EH, UK
2. Division of Nutrition, Department of Paediatrics, Faculty of Medicine, Chiang Mai University, Thailand

* Corresponding author: Sarah Dib [sarah.dib.15@ucl.ac.uk]

Abstract:

Background: Late preterm (born at $34^{0/7}$ to $36^{6/7}$ gestational weeks) and early term infants ($37^{0/7}$ to $38^{6/7}$ gestational weeks) are at higher risk of morbidity and mortality compared to more mature infants. Breastfeeding can reduce these risks, but feeding difficulties are common among these infants and breastfeeding rates are low. We conducted a systematic review to identify the interventions available to improve any breastfeeding, exclusive breastfeeding or breast milk yield.

Methods: A literature search was performed up to February 23, 2022, using MEDLINE, CINAHL, Embase, and Google Scholar, and nine articles were included. Only one article was a randomized controlled trial, and only one included early term infants. The remaining articles were quasi-experimental and included only late preterm infants. Outcomes included breastfeeding duration, breastfeeding exclusivity, and/or breast milk production (volume) before 6 months actual age.

Results: Professional support significantly improved exclusive breastfeeding rates. A breastfeeding education program delivered at the hospital with weekly telephone follow-up post-discharge significantly increased breastfeeding rates. Neither cup-feeding nor early discharge (with in-home lactation support) improved breastfeeding rates, whereas rooming-in (vs direct admission to the NICU) worsened exclusive breastfeeding rates.

Discussion: This is the first systematic review to identify interventions available for both late preterm and early term infants. Overall, there are limited studies that investigate interventions promoting breastfeeding in these populations. However, breastfeeding support delivered by healthcare professionals seems to improve breastfeeding rates. The main limitations are the lack of randomization, blinding and adjustment for confounding variables. Experimental studies with robust methodological design are needed.

Background:

More than 1 in 10 babies are born preterm worldwide,[1] and this rate is rising in almost all countries. Prematurity is the leading cause of death in children under the age of five years in nearly all high- and middle-income countries and is associated with a higher risk of health complications such as chronic respiratory problems, diabetes and hypertension.[2]

It was suggested that preterm birth rates have primarily increased overall due to the dramatic rise in late preterm births ($34^{0/7}$ and $36^{6/7}$ gestational weeks),[3] which constitute 74% of all preterm births.[4] Previously, not enough attention has been paid to late preterm infants (LPI) due to the incorrect assumption that these infants may be physiologically and metabolically as mature as term infants, as they may appear of appropriate size at birth. However, LPI have a significantly higher risk of morbidity and mortality compared to term infants.[5]

Another category of infants that has gained more attention in recent years is early term infants (ETI), who are infants born between $37^{0/7}$ and $38^{6/7}$ gestational weeks and account for 23% of all live births.[6] The categorization was developed to highlight the higher risk of morbidity and mortality of ETI compared to those born at 39 - 41 weeks.[7] Despite the complications they experience,[8] like LPI, most ETI are of healthy weight at birth and have normal Apgar scores which might lead to false reassurance among health professionals.

Both groups are at higher risk of breastfeeding complications compared to infants born later.[9-11] This could be due to infant-related barriers associated with earlier birth, such as rapid fatigue during feeding, lower stamina, fewer awake periods, and reduced effort to stimulate and empty the breast.[12] It could also be due to maternal-related barriers associated with preterm delivery, such as caesarean delivery, obesity, multiple births, smoking status or maternal psychological distress.[8, 9, 11-13] Additionally, since ETI are still within the broad full-term categorization, they might not be receiving special attention to overcome the challenges associated with an earlier birth.

Reduced breastfeeding rates in these two groups is an important issue to tackle as all infants benefit from breastfeeding, but especially those born earlier. Due to their developmental immaturity and increased susceptibility to inflammation, oxidative stress and infections, breast milk and the constituents of breast milk such as antibodies, growth factors, bacteria, lipids and enzymes (which are variable with gestational age) are particularly beneficial.[14]

Given both the benefits of breast milk for LPI and ETI, and the breastfeeding difficulties often experienced by their mothers, it is important to understand what interventions may successfully promote breastfeeding in these populations. Two previous systematic reviews have investigated breastfeeding promotion interventions for LPI

(one also included moderately-preterm infants).[15, 16] To our knowledge, no review was previously undertaken on available breastfeeding promotion interventions for ETI.

We conducted a systematic review with the aim of examining the available interventions for LPI and ETI that target breastfeeding outcomes. The outcomes included breastfeeding duration and exclusivity, but also breast milk production since many mothers might be dependent (partially or fully) on milk expression in the early postnatal period. In contrast to one of the previous reviews,[16] we only included experimental studies, and specified no language or time restrictions.

The research question that this review addressed follows the PICOS (participants, interventions, comparators, outcomes, study design) model: What is the evidence on the effect of interventions available for LPI and ETI on breastfeeding duration/exclusivity or breast milk production?

Methods:

Inclusion Criteria

Participants:

Studies including LPI or infants born in a period overlapping $34^{0/7}$ to $36^{6/7}$ gestational weeks by at least two weeks (34-35 weeks or 35-36 weeks) were eligible for inclusion. Studies that included ETI or infants born in a period overlapping $37^{0/7}$ and $38^{6/7}$ gestational weeks by at least one week (37 weeks or 38 weeks) were also eligible. If the sample included more than just late preterm or ETI, data needed to be presented separately for these categories.

Interventions & **C**omparators:

Studies investigating any type of intervention or combination of interventions provided with the aim of promoting breastfeeding or breast milk provision, in any setting but starting within one month of birth were eligible. Comparators could be other interventions but must also include some type of control, including usual care, placebo, or no-treatment.

Outcomes:

The outcomes of the interventions included breastfeeding duration, breastfeeding exclusivity, and/or breast milk production (volume) at a time point before 6 months actual age.

Study Design:

Only randomized controlled trials (RCTs) or quasi-experimental studies (non-randomized interventional studies) were eligible for inclusion. Observational studies were excluded due to their inability to establish causation.

Searches

1. The following databases were searched in February 2022: MEDLINE, CINAHL, Embase, Google Scholar; without time or language restrictions. The search terms included: breastfeeding, breast milk, premature infants, ETI, 37-38 weeks, 37-38 gestation, term birth and similar words (Table 1). The full search and screening protocol was registered in PROSPERO (CRD42020187000).

2. Randomized controlled trials and non-randomized controlled trials (quasi-experimental studies) were extracted from the search.

3. Other relevant papers were sought by backward reference searching of the included papers.

[Insert Table 1 here]

Study selection

The search results were imported to EndNote X9 where duplicates were removed. An initial screening of the titles and abstracts against inclusion criteria was conducted by two reviewers independently (SD and KK). This was followed by a screening of the full texts of relevant papers. Discrepancies were resolved by discussion and by consulting a third reviewer (MF).

Data extraction

The guidelines from the Centre for Reviews and Dissemination[17] were followed to generate the data extraction forms. For this review, guidelines of the Preferred Reporting Items of Systematic reviews Meta-Analysis (PRISMA) were followed. Details of methodological quality, study design, sample and intervention were abstracted. For each outcome, the time point, the numeric results, the statistic used, and the p value was abstracted.

Quality assessment

Two reviewers (SD and KK) independently assessed the risk of bias based on the Cochrane group methods for systematic reviews (details provided in Supplementary Data). Discrepancies were resolved by discussion with involvement of a third review author (MF) where necessary. The level of risk of bias in each of these domains was presented separately for each study.

Data synthesis

Included studies were too diverse (various interventions, targeting different age groups, outcomes at different time points) for a quantitative synthesis. Therefore, a narrative synthesis was undertaken. Results were classified according to the outcome: breastfeeding duration, breastfeeding exclusivity, or breast milk production. They were further grouped according to the target population (LPI vs ETI).

Results:

Based on the search strategy, 2408 records were identified from the four databases. As shown in Figure 1, after duplicates were removed, 1556 titles were screened after which 372 abstracts were assessed for eligibility. After 63 full texts were screened, 9 articles were included for this review (Table 2). Two studies reported outcomes related to 'exclusive breastfeeding' only,[18, 19] two related to 'any breastfeeding' only,[20, 21] and the other five related to both 'any breastfeeding' and 'exclusive breastfeeding'.[22-26] None of the studies reported on breast milk volume. Only one study was a randomized controlled trial,[18] the rest were quasi-experimental (non-randomized). Only one study included infants of 37 weeks gestation,[18] the rest included late preterm infants exclusively. The studies included 1325 infants of which 20 were of 37 weeks gestation (early term infants) and the rest were late preterm.

[Insert Figure 1 here]
[Insert Table 2 here]

Interventions:

All the interventions in the included studies involved breastfeeding support delivered by health professionals. McKeever et al.[18] investigated early hospital discharge coupled with breastfeeding support delivered at home by lactation consultants. Maastrup et al.[19] investigated a neonatal nurse training program that focused on improving certain hospital practices such as early breast milk expression, skin-to-skin contact, and rooming-in. Estalella et al.[23] targeted hospital practices that could improve breastfeeding such as bedside phototherapy and more detailed evaluation of breastfeeding. Similarly, Dani et al.[26] explored rooming-in assistance in comparison to

direct admission to NICU. Abouelfettoh et al.[24] studied the influence of cup-feeding for late preterm infants admitted to a NICU, compared to bottle-feeding. The remaining studies were education-based interventions designed specifically for late preterm infants. The first involved a 4-session/intervention education program which covered topics such as the characteristics of LPI, breastfeeding the LPI and post-discharge management delivered face-to-face at the hospital before discharge.[20] Mothers were also followed up with on a weekly basis, for a month post-discharge, via telephone to offer them emotional support and to allow them to ask questions. The other three studies covered education on late preterm topics over 4 home visits but also offered individualized practical breastfeeding support and advice to express breast milk regularly.[21, 22, 25]

Exclusive Breastfeeding:

McKeever et al.[18], who conducted the only RCT included, showed that home lactation support compared to hospital support did not improve breastfeeding exclusivity at 5-12 days postpartum in LPI and EPI (37 weeks). Dani et al.[26] found that rooming-in assistance rather than direct admission to NICU resulted in lower exclusive breastfeeding rates. Conversely, one quasi-experimental study reported twice the odds of exclusive breastfeeding at discharge in late preterm infants whose mothers received an intervention designed to promote breastfeeding in this population.[23] Two other studies showed that a breastfeeding support intervention delivered over 4 weeks increased exclusive breastfeeding at the second, third and fourth week post-delivery (OR= 7.1, 95% CI 1.7, 29.9; OR= 12.0, 95% CI 2.7, 52.9; and OR= 15.2, 95% CI 3.3, 69.2)[22] or at four weeks post-delivery (OR=4.0, 95% CI 1.2, 12.6)[25], compared to the control group. Maastrup et al.[19] also found that the intervention (nurse training program) resulted in higher odds of exclusive breastfeeding at discharge (OR=1.3; 95% CI 0.8, 2.3) in infants born at 35-36 weeks. Lastly, Abouelfettoh et al.[24] showed that the proportion of feedings that were breast milk (direct or expressed) at one week post-discharge was significantly higher in the cup-feeding (80.2%; 95% CI 70.6, 89.8) group than in the bottle-feeding group (64.4%; 95% CI 53.4, 75.4), although there were no significant differences in the proportion who were exclusive breastfeeding between the two groups.

Any Breastfeeding:

Estalella et al.[23] also investigated breastfeeding at discharge as an outcome. Breastfeeding rate was lower in the intervention group (25.9%) compared to the control group (37.8%), a reflection of the significantly higher exclusive breastfeeding rate in the intervention group rather than more formula feeding. Jang & Hong[22] showed that there was a small increase in breastfeeding rate in the experimental group compared to the control group, but the lack of the large increase is again a reflection of the noticeable increase in exclusive breastfeeding. Similarly, another quasi-experimental study revealed that the intervention group who received a 4-session

education program had 3.9 times the odds (95% CI 1.2, 12.6) of breastfeeding at one month post-discharge compared to the control group.[20] Conversely, three studies[21, 25, 26] did not find any significant differences in breastfeeding rates between the intervention and control groups.

Breast Milk Volume:

None of the included studies reported breast milk volume as an outcome.

Quality of the studies:

The quality of each study was assessed according to six domains. Only one RCT was included in this review, in which the method of randomization sequence generation was not mentioned.[18] While the researchers collecting the data were originally blinded to the group status, the participants were not blinded to the intervention due to its nature (early discharge, home support) and later revealed their status during the interviews.

The other eight studies were of quasi-experimental design, where the researchers and the participants were aware of the group allocation. Six of the studies collected data at different periods for the control and experimental groups (~1-year gap)[19-21, 23, 25, 26] and one of which was also carried out at different hospitals for each group[26], which might have introduced a bias in the characteristics of the sample. However, Estallela et al.[23] and Maastrup et al.[19] reported no significant differences in the baseline characteristics between the control and experimental group (there were fewer extremely preterm infants in the Maastrup et al.[19] but this not relevant to this review). Similarly, Jang and Hong[22], Jang and Ko[21], and Jang and Ju[20] reported no significant differences at baseline, but there were some notable differences in infant characteristics which might have contributed to the findings. On the other hand, the remaining three quasi-experimental studies found significant differences in baseline characteristics.[24-26] Both Dani et al.[26] and Jang[25] provided an adjustment for the differences in infant characteristics, whereas Abouelfettoh et al.[24] did not account for the significantly higher birthweight in the cup-feeding group compared to the bottle-feeding group at baseline.

Other study quality concerns are evident. For example, there was a high number of attrition in Abouelfettoh's study,[24] where only 13/30 participants in the intervention group but 25/30 in the control group maintained participation by 6 weeks. The differences in characteristics between participants included and lost to follow-up were not investigated, and the results of the first week only were reported despite the intention to investigate breastfeeding practices at 1-6 weeks post-discharge. In three other studies, it is unclear how the decision to allocate infants to each group was made which might produce a high risk of bias[21, 22, 25]. Additionally, it is uncertain how the intervention investigated by Jang[25] and Jang and Ko[21] was modified from the one

developed by Jang and Hong[22]. Lastly, it also unclear why the breastfeeding/mixed-feeding rates were reported differently in Jang[25] and Jang and Ko[21] despite involving the same sample.

[Insert Table 3 here]

Discussion:

The findings from this review are inconclusive but might indicate that breastfeeding support interventions delivered by health professionals in the early postnatal period (birth-4 weeks) can be beneficial at improving exclusive breastfeeding duration in late preterm infants.

Professional Breastfeeding Support and Hospital Practices

McKeever et al.[18] found that in-home lactation support did not increase exclusive breastfeeding. While the authors aimed to investigate early discharge of infants of 35-37 weeks' gestation with the additional in-home lactation support, there were no significant differences in length of hospital stay between groups (45 vs 48 hours). This was because they did not meet the early discharge criteria and because of the already existing practice of early discharge for LPI. Several studies have shown that LPI who were discharged early were more likely to be re-admitted.[27-29] Similarly, a recent study showed that early discharge (<48 hours) of healthy LPI was not associated with cost savings, probably due to the higher risk of rehospitalization after early discharge.[30] In all these studies, the most common reason for rehospitalization was jaundice. Therefore, it is possible that early discharge for LPI does not allow for enough time to support breastfeeding practices and establish adequate breast milk supply. Nevertheless, other similar studies have also shown no significant differences in exclusive breastfeeding rates between the two groups.[31, 32]

Estalella et al.[23] delivered an intervention where hospital practices were changed with the aim of promoting parents' education and involvement, avoiding separation from the infant (when phototherapy is provided), and creating a multidisciplinary approach to support breastfeeding. The results showed that the intervention group had higher exclusive breastfeeding rate at discharge. This could be partially explained by the significantly higher proportion of mothers in the intervention group expressing breast milk after some or all of the feeds. The results should be interpreted with caution due to the quasi-experimental design and the one-year gap in data collection, however no significant differences were found in the baseline characteristics and the sample size was relatively large with only a few exclusions. Additionally, Maastrup et al.[19] investigated another intervention that aimed at improving hospital practices supportive of breastfeeding such as skin-to-skin contact, rooming-in, and early breast milk expression. The findings also revealed an increase in exclusive breastfeeding rates in

the intervention group. As with Estallela et al.,[23] the study involved a large sample with low risk of bias.

Jang and Ju[20] designed a within-hospital breastfeeding education intervention for mothers of LPI admitted to the NICU, but this was followed by weekly phone call check-ups (for one month) after discharge. The results showed that at one-month post-discharge breastfeeding rates and parenting confidence were significantly higher in the experimental group compared to the control group. However, there are several limitations to the study, such as the quasi-experimental design, the one-year gap in data collection, and higher proportion of infants of 34 weeks' gestation and lower proportion of infants of 36 weeks' gestation in the control group vs intervention group at baseline. Other observational studies have also analyzed the association between hospital practices and support on breastfeeding in LPI. A study including 579 LPI from the UK 2010 Infant Feeding Survey showed that mothers who reported that they did not receive enough support with breastfeeding at the hospital were less likely to be breastfeeding at 10 days.[33] Another showed that high levels of professional support at the hospital was associated with an increased likelihood of any breastfeeding in late preterm, early term and term infants.[10]

Jang and Hong,[22] Jang[25] and Jang and Ko[21] evaluated a breastfeeding education/coaching/support program delivered at discharge and over four home visits after (once per week). In the initial period, the intervention encouraged mothers to express breast milk to increase production, then later provided practical instruction on latching and positioning. The results suggested an improvement in exclusive breastfeeding rates, however, there were some differences in infant characteristics at baseline as well as other study quality concerns. Similarly, a RCT has shown that a program involving 11 one-hour sessions pre- and post-discharge, aiming to educate parents on their infant's characteristics and improve responsiveness to cues and interaction, increased breastfeeding duration in mothers of moderately and late preterm infants at 6, 9 and 12 months post-discharge, although the effects were only significant at 9 months.[34] Another RCT which included mainly moderately and late preterm infants (n=414; 84%) from 6 NICUs in Sweden found no significant differences in exclusive breastfeeding at 8 weeks between the proactive telephone support group (received daily telephone calls from day 1 to day 14 post-discharge from a member of the breastfeeding support team) and the reactive telephone support group (given the option to call a member from the team if they face any breastfeeding problems) [35]. However, mothers in the proactive telephone support group reported less parental stress at 8 weeks post-discharge. This might indicate the importance of face-to-face support for practical breastfeeding difficulties, whereas telephone support might be beneficial for emotional support.

Dani et al.[26] compared direct admission to the NICU in one hospital to providing rooming-in assistance and only admitting to NICU if necessary in another hospital. The odds of exclusive breastfeeding were lower in the hospital that provided rooming-

in assistance (OR= 0.17; 95% CI 0.07, 0.4). This could be explained by the differences in infant characteristics between the two hospitals. It might also be possible that infants admitted to the NICU are recognized to be more vulnerable and thus their parents might be provided with more support to breastfeed and with more encouragement to express breast milk.

Early Breastmilk Expression and Supplementation

The above-mentioned studies provide further evidence that breast milk expression might be a crucial factor that increases the likelihood of exclusive/any breastfeeding in LPI.[19-22, 25] A prospective survey in Denmark including 1,488 preterm infants with a gestational age of 24–36 weeks, 483 of which were 35-36 weeks, found that delayed initiation of breast milk expression beyond 6 hours post-delivery had a dose-response association with failure to exclusively breastfeed (directly at the breast) at discharge.[36] Multiple factors in the early postnatal period after a late preterm/early term birth might necessitate expressing breast milk. For example, LPI often have lower stamina and fewer awake periods leading to reduced effort to stimulate the breast which might lead to decreased breast milk production and ejection. As a result, LPI are commonly supplemented with infant formula which might further interfere with establishment of breast milk. Therefore, breast milk expression could be beneficial in maintaining or increasing breast milk supply whilst simultaneously providing nutrients to less mature infants who might be unable to feed effectively.

A comparative study that investigated the influence of formula supplementation in the hospital on breastfeeding rates in LPI found that 87% of infants who were exclusively breastfed from birth were exclusively breastfed at discharge compared to 24% who were supplemented with formula regularly from birth.[37] The study also showed that 65% of mothers whose infants were prescribed breast milk substitutes on a regular basis never used a breast pump, while the rest took an average of 42 hours before using one. Therefore, the low exclusive breastfeeding rates may be partially explained by the inadequate milk expression to establish breastfeeding, and also due to formula volume exceeding the amount of milk the infant would receive at the breast, though this was not investigated in this study.

The method by which supplementation, whether breast milk or formula milk, is delivered to LPI has also been studied. Abouelfettoh et al.[24] showed that infants fed by cup had a higher proportion of feedings that were breast milk at one week post-discharge compared to infants fed by bottle. Likewise, in another study including LPI, that was defined in the study as 32 to 35 weeks gestation, exclusive breastfeeding was significantly higher at discharge, 3 months and 6 months, and breastfeeding was significantly higher at discharge and 6 months in the cup feeding group.[38] However, both studies had several methodological limitations, including the lack of information on breast milk expression practices and the high level of attrition. Moreover, the

analysis was not intention to treat,[38] and 85 participants were excluded for non-compliance, which introduced bias to the study results.

Kangaroo Mother Care

Mörelius[39] and Hake-Brooks, Anderson [40] conducted two RCTs that studied kangaroo mother care but which were not included in this review because the data was not analyzed separately for late preterm vs more preterm infants. Mörelius[39] found that in infants (32-36 GA) admitted to the NICU, breastfeeding rates were higher in the continuous skin-to-skin group compared to infants in the standard care group, at discharge (100% vs 84%) and at one (94% vs 74%) and four months (77% vs 53%) corrected age, although the results were not statistically significant. In the other study, in infants of 32-36 GA, kangaroo care significantly increased breastfeeding mand breastfeeding exclusivity at 6 months, compared to control.[40] The discrepancy in the significance might be due to the difference in the duration skin-to-skin was practiced. For example, Hake-Brooks, Anderson [40] reported that participants in the intervention group practiced skin-to-skin for an average of 4.47 hours per day, whereas Mörelius[39] reported 7 hours of skin-to-skin per day on average in the control group.

Similar evidence was reported in a few observational studies. For example, a cohort study conducted in the UK also found that kangaroo mother care increased breastfeeding rates at discharge and reduced average length of hospital stay in LPI, small-for-gestational age infants and infants of diabetic mothers.[41] Likewise, in a quasi-experimental study involving a large sample of LPI and their mothers, mothers who chose to provide kangaroo mother care were twice as likely to exclusively breastfeed at discharge and at 42 days post-delivery compared with mothers who opted not to.

Alternative and Relaxation Therapies

The use of herbal therapies and meditation audio for mothers of late preterm and early term infants with perceived insufficient milk supply was investigated.[43] The study did not report significant differences in breast milk volume or breastfeeding status, however this is probably due to the small sample size (n=11) which was underpowered to detect differences. Additionally, the study did not include a control comparator, which is why it was not included in this review. Nevertheless, the study showed that these two complementary and alternative therapies are safe and acceptable in this population. Other relaxation interventions such as music and meditation were shown to be beneficial at increasing breast milk volume in mothers of preterm infants[44, 45] and in full-term infants.[46] However, their efficacy was not studied in late preterm or early term infants specifically, and further investigation is warranted.

Conclusion

In summary, professional breastfeeding support and education programs tailored to LPI might improve breastfeeding and/or exclusive breastfeeding rates. Other interventions such as early breast milk expression, kangaroo mother care and relaxation therapies are promising and warrant more investigation in this population using robust study design. Overall, there are limited experimental studies that exclusively include LPI or ETI, or present the data for these groups separately. Additionally, since the experiments are mainly conducted in single hospitals which makes randomizing infants and avoiding cross-contamination difficult, 8/9 studies in this review are quasi-experimental. This introduces confounding bias and limits their ability to conclude a causal association, which is especially true in 6/8 quasi-experimental studies in this review that were found to have differences at baseline. Therefore, randomized controlled trials that target late preterm and early term infants are needed to improve breastfeeding and health outcomes for these infants. More interventions that are delivered post-discharge are also needed, as many of these infants do not have long hospital stays and thus their mothers might require support at home.

Author Contribution

SD and MF proposed the idea and concept of this review. SD conducted the search and screened the titles. SD and KK screened the abstracts and full-text articles and assessed the quality of the studies. SD drafted the manuscript, and JW, MF, and KK edited the manuscript and contributed critical intellectual input. All authors approved the final manuscript for submission.

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References

1. Blencowe H, Cousens S, Oestergaard MZ, et al. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. Lancet 2012;379(9832):2162-72.

2. Crump C. An overview of adult health outcomes after preterm birth. Early Hum Dev 2020;150:105187.
3. Committee on Obstetric Practice ACOG committee opinion No. 404 April 2008. Late-preterm infants. Obstet Gynecol 2008;111(4):1029-1032.
4. Davidoff MJ, Dias T, Damus K, et al. Changes in the gestational age distribution among US singleton births: impact on rates of late preterm birth, 1992 to 2002.Semin Perinatol. 2006;30(1):8-15.
5. Wang ML, Dorer DJ, Fleming MP, et al. Clinical outcomes of near-term infants. Pediatrics 2004;114(2):372-6.
6. Richards JL, Kramar 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(4):410-9.
7. Engle WA. Morbidity and mortality in late preterm and early term newborns: a continuum. Clin Perinatol 2011;38(3):493-516.
8. Brown HK, Speechley KN, Macnab J, et al. Neonatal morbidity associated with late preterm and early term birth: the roles of gestational age and biological determinants of preterm birth. Int J Epidemiol 2014; 43(3):802-14.
9. Hackman NM, Alligood-Percoco N, Martin A, et al., Reduced breastfeeding rates in firstborn late preterm and early term infants. Breastfeed Med 2016;11(3):119-25.
10. Goyal NK, Attanasio LB,Kozhimannil KB. Hospital care and early breastfeeding outcomes among late preterm, early-term, and term infants. Birth 2014;41(4)330-8.
11. 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. Arc Di Child Fetal Neonatal Ed 2015;100(6):F479-F485.
12. Kair LR,Colaizy TT. Breastfeeding continuation among late preterm infants: barriers, facilitators, and any association with NICU admission? Hosp Pediatr 2016;6(5):261-8.
13. Crippa BL, Colombo L, Morniroli D, et al. Do a few weeks matter? Late preterm infants and breastfeeding issues. Nutrients 2019;11(2):312.

14. Andreas, N.J., Kampmann B, and Le-Doare KM. Human breast milk: A review on its composition and bioactivity. Early Hum Dev 2015; 91(11):629-35.
15. Carpay NC, Kakaroukas A, Embleton ND, et al. Barriers and Facilitators to Breastfeeding in Moderate and Late Preterm Infants: A Systematic Review. Breastfeed Med 2021;16(5):370-84.
16. Cartwright J, Atz T, Newman S, et al. Integrative review of interventions to promote breastfeeding in the late preterm infant. J Obstet, Gynecol Neonatal Nurs 2017;46(3):347-56.
17. Akers J, Aguiar-Ibáñez R, Baba-Akbari A, (eds). Systematic reviews: CRD's guidance for undertaking reviews in health care. Centre for Reviews and Dissemination, University of York: UK;2009.
18. McKeever P, Steven B, Miller KL, et al. Home versus hospital breastfeeding support for newborns: a randomized controlled trial. Birth 2002;29(4):258-65.
19. Maastrup R, Rom AL, Walloee S, et al. Improved exclusive breastfeeding rates in preterm infants after a neonatal nurse training program focusing on six breastfeeding-supportive clinical practices. PLoS One 2021;**16**(2): e0245273.
20. Jang EH, Ju HO. Effects of an infant care education program for mothers of late-preterm Infants on parenting confidence, breastfeeding rates, and infants' growth and readmission rates. Child Health Nur Res 2020;26(1):11-22.
21. Jang GJ, Ko S. Effects of a breastfeeding coaching program on growth and neonatal jaundice in late preterm infants in South Korea. Child Health Nurs Res 2021;27(4):377-84.
22. Jang GJ, Hong YR. Effects of a Breastfeeding Support Program on the Prevalence of Exclusive Breastfeeding and Growth in Late Preterm Infants. Child Health Nur Res 2020;26(1):90-7.
23. Estalella I, Millan JS, Trinacado MJ, et al. Evaluation of an intervention supporting breastfeeding among late-preterm infants during in-hospital stay. WomenBirth 2020;33(1):e33-e38.
24. Abouelfettoh AM, Dowling DA, Dabash SA, et al. Cup versus bottle feeding for hospitalized late preterm infants in Egypt: a quasi-experimental study. Int Breastfeed J 2008;3(1):1-11.
25. Jang GJ. Influence of a breastfeeding coaching program on the breastfeeding rates and neonatal morbidity in late preterm infants. Child Health Nurs Res 2020;26(3):376-84.
26. Dani C, Ciarcia M, Miselli F, et al. The management of late preterm infants: effects of rooming-in assistance versus direct admission to neonatal care units. Eur J Pediat 2022;181(4):1643-9.

27. Tomashek KM, Shapiro-Mendoza C, Weiss J, et al. Early discharge among late preterm and term newborns and risk of neonatal morbidity. Semin Perinatol 2006;30(2):61-8.
28. Escobar GJ, Greene JD, Hulac P, et al. Rehospitalisation after birth hospitalisation: patterns among infants of all gestations. Arch Dis Child 2005;90(2):125-31.
29. Escobar GJ, Joffe S, Gardner MN, et al. Rehospitalization in the first two weeks after discharge from the neonatal intensive care unit. Pediatrics 1999; 104(1):e2.
30. Isayama T, O' Reilly D, Beyene J, et al. Hospital care cost and resource use of early discharge of healthy late preterm and term singletons: a population-based cohort study and cost analysis. J Pediatr 2020;226:96-105.
31. Holm KG, Clemensen J, Brodsgaard A, et al. Growth and breastfeeding of preterm infants receiving neonatal tele-homecare compared to hospital-based care. J Neonatal Perinatal Med 2019;12(3):277-84.
32. Gunn TR, Thompson JM, Jackson H, et al. Does early hospital discharge with home support of families with preterm infants affect breastfeeding success? A randomized trial. Acta Paediatr 2000;89(11):1358-63.
33. 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(11):e009144.
34. 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 Beha Dev 2012;35(1):36-47.
35. Ericson J, Eriksson M, Hellstrom-Westas L, et al. Proactive telephone support provided to breastfeeding mothers of preterm infants after discharge: a randomised controlled trial. Acta Paediatr 2018;107(5):791-8.
36. 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(2):e89077.
37. Mattsson E, Funkquist E, Wickstrom M, et al. Healthy late preterm infants and supplementary artificial milk feeds: effects on breast feeding and associated clinical parameters. Midwifery 2015;31(4):426-31.

38. 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(2):174-9.
39. Mörelius E, Ortenstrand A, Theodorsson E, et al. A randomised trial of continuous skin-to-skin contact after preterm birth and the effects on salivary cortisol, parental stress, depression, and breastfeeding. Early Hum Dev 2015;91(1):63-70.
40. Hake-Brooks SJ, Anderson GC. Kangaroo care and breastfeeding of mother-preterm infant dyads 0-18 months: a randomized, controlled trial. Neonatal Netw 2008;27(3):151-9.
41. Gregson S, Blacker J. Kangaroo care in pre-term or low birth weight babies in a postnatal ward. Br J Midwifery 2011;19(9):568-77.
42. Zhang B, Duan Z, Zhao Y, et al. Intermittent kangaroo mother care and the practice of breastfeeding late preterm infants: results from four hospitals in different provinces of China. Int Breastfeed J 2020;15(1):1-9.
43. Demirci JR, Bare S, Cohen SM, et al. Feasibility and acceptability of two complementary and alternative therapies for perceived insufficient milk in mothers of late preterm and early term infants. Altern Complement Ther 2016; 22(5):196-203.
44. Keith DR, Weaver BS, Vogel RL. The effect of music-based listening interventions on the volume, fat content, and caloric content of breast milk-produced by mothers of premature and critically ill infants. Adv Neonatal Care 2012;12(2):112-9.
45. Feher SD, Berger LR, Johnson JD, et al., Increasing breast milk production for premature infants with a relaxation/imagery audiotape. Pediatrics 1989;83(1):57-60.
46. Mohd Shukri NH, Wells J, Eaton S, et al. Randomized controlled trial investigating the effects of a breastfeeding relaxation intervention on maternal psychological state, breast milk outcomes, and infant behavior and growth. Am J Clin Nutr 2019;110(1):121-30.

Table 1. Keywords and MeSH used in literature search and search strategy used.

No.	Search Strategy	Map term to subject heading (MeSH)	Keyword
1	MeSH OR Keywords for Breastfeeding	Breast feeding/	Breastfeeding or Breast Feeding or Human Milk or Breast milk or Breastmilk or lactation
2	MeSH OR Keywords for Late Preterm	Infant, Premature/	Late preterm infant* or late preterm newborn* or Late premature infant* or late premature newborn* or near term
3	MeSH OR Keywords for Early Term	-	Early term infant* or early term newborn*
4	2 OR 3	(Infant, Premature/ or Late preterm infant* or late preterm newborn* or Late premature infant* or late premature newborn* or near term) OR (Early term infant* or early term newborn*)	
5	1 AND 4	(Breastfeeding or Breast Feeding or Human Milk or Breast milk or Breastmilk or Lactation) AND ((Infant, Premature/ or Late preterm infant* or late preterm newborn* or Late premature infant* or late premature newborn* or near term) OR (Early term infant* or early term newborn*))	

Table 2. Data extraction of included studies

Author, Year, Location	Study Design[a]	Population[b]	Intervention & Comparators	Outcomes[c]	Time point	Main Result[d]
McKeever et al., 2002, Canada[18]	RCT	101 term infants 37 LPI (35-37)	Standard hospital care with early discharge and home support from nurses who were lactation consultants vs standard hospital care and standard length of hospitalization	-EBF (feeding by breast only) -Exclusive breast milk feeds (feeding only breast milk by breast or bottle)	-At discharge -5- 12 days postpartum	-The intervention had no effect on EBF (OR=1.4; 95% CI 0.3, 7.2)
Maastrup et al., 2021, Denmark[19]	QE	110/421 control LPI ($35^{0/7}$ – $36^{6/7}$) 142/494 intervention LPI ($35^{0/7}$ – $36^{6/7}$)	Standard care (pre-intervention) vs neonatal nurse training program (with focus on early breastmilk expression, skin-to-skin contact, rooming-in, use of test-weighing and minimizing use of pacifiers)	-EBF (feeding by breast only)	-At discharge	-The intervention had 1.3x the odds of EBF at discharge (95% CI 0.8, 2.3) in infants born at 35-36 weeks (study is not powered to detect sub-gestational group differences).
Jang & Ju, 2020, Korea[20]	QE	27 control LPI ($34^{0/7}$ – $36^{6/7}$) 26 intervention LPI ($34^{0/7}$ – $36^{6/7}$)	Standard care vs 4-session LPI education program (characteristics of LPI, BF for LPI, post-discharge management of LPI, emotional support)	BF (newborn received any breast milk)	-At discharge -One month post-discharge	- OR of 3.9 (95% CI 1.2, 12.6) of breastfeeding at one-month post-discharge in the experimental group.

Author, Year, Location	Study Design	Population	Intervention & Comparators	Outcomes	Time point	Main Result
Jang & Ko, 2021, Korea[21]	QE	19 control LPI ($34^{0/7}$ – $36^{6/7}$) 21 intervention LPI ($34^{0/7}$ – $36^{6/7}$)	Control group (4 homes visits with counselling related to nurturing LPIs) vs breastfeeding coaching program (web-based BF education program involving 4 home visits, practical BF support based on infant's and mother's needs, and encouragement and advice to express milk regularly)	-BF (feeding by breast, or bottle-feeding pumped milk and/or small amounts of formula once or twice a day)	-At discharge -1st week -2nd week -3rd week -4th week	-The interaction effect between treatment and time had an OR of 1.2 (95%CI 0.6, 2.5), 1.3 (0.5, 3.12), 2.4 (0.6, 9.3) and 3.7 (1.0, 14.2) for the 1st, 2nd, 3rd and 4th week, respectively.
Jang & Hong, 2020, Korea[22]	QE	20 control LPI ($34^{0/7}$ – $36^{6/7}$) 20 intervention LPI ($34^{0/7}$ – $36^{6/7}$)	Control group (4 homes visits with counselling related to nurturing LPIs) vs breastfeeding support program (web-based BF education program involving 4 home visits, practical BF support based on infant's and mother's needs, and encouragement and advice to express milk regularly)	EBF (feeding by breast only) Mixed feeding (feeding breast milk by breast or bottle, and supplemented with formula milk)	-At discharge -1st week -2nd week -3rd week -4th week	-OR of 5.2 (95% CI 1.1, 16.7) of EBF overall and 7.1 (95% CI 1.7, 29.9), 12.0 (95% CI 2.7, 52.9), and 15.2 (95% CI 3.3, 69.2) the odds of EBF at 2, 3, and 4 weeks, respectively.
Estalella et al, 2020, Spain[23]	QE	212 control LPI ($34^{0/7}$ – $36^{6/7}$) 161 intervention LPI ($34^{0/7}$ – $36^{6/7}$)	Standard care (recommendations provided on a sheet, BF evaluated verbally, visits conducted separately by pediatrician and nurse, phototherapy at NICU) vs Intervention (postnatal booklet provided, BF evaluated by chart, visits conducted together, phototherapy at bedside)	-EBF (newborn received breast milk) -BF(newborn received breast milk and human milk substitute)	-At discharge	-The intervention group had twice the odds of EBF (OR=2.1; 95% CI 1.4, 3.2).

Author, Year, Location	Study Design	Population	Intervention & Comparators	Outcomes	Time point	Main Result
Abouelfettoh et al, 2008, Egypt[24]	QE	30 control LPI ($34^{0/7}$ – $36^{6/7}$) 30 intervention LPI ($34^{0/7}$ – $36^{6/7}$)	Control group (bottle-feeding all oral feeds at the NICU) vs Intervention group (cup-feeding all oral feeds at the NICU)	- EBF (feeding breast milk only)	- Weeks 1, 2, 3, 4, 5, and 6 post-discharge	-The intervention did not increase exclusive breastfeeding at 1 one week post-discharge (OR=1.8; 95% CI 0.6, 5.0).
Jang, 2020, Korea[25]	QE	19 control LPI ($34^{0/7}$ – $36^{6/7}$) 21 intervention LPI ($34^{0/7}$ – $36^{6/7}$)	Control group (4 homes visits with counselling related to nurturing LPIs) vs breastfeeding coaching program (web-based breastfeeding education program involving 4 home visits, practical breastfeeding support based on infant's and mother's needs, and encouragement and advice to express milk regularly)	-BF (feeding by breast or bottle-feeding pumped milk) -Mixed feeding (feeding breast milk by breast or bottle, and supplemented with formula milk)	-At discharge -1st week -2nd week -3rd week -4th week	-OR for BF (adjusted for length of hospital stay and newborn disease) was 13.7 (95%CI 1.2, 157.0) and 20.6 (95%CI 2.0, 214.4 at the third and fourth week, respectively.
Dani et al., 2022, Italy[26]	QE	190 control LPI ($35^{0/7}$ – $36^{6/7}$) 240 intervention LPI ($35^{0/7}$ – $36^{6/7}$)	Standard care at hospital 1 (LPI directly admitted to SCU/NICU) vs rooming-in assistance at hospital 2 (followed by admission to SCU/NICU if needed).	-EBF (newborn fed only breast milk including human donor milk and/or expressed breast milk) -Mixed (any breastfeeding mixed with formula feeding)	-At discharge	-The intervention reduced the odds of EBF (OR= 0.2; 95% CI 0.1, 0.4) in infants born at hospital 2 (rooming-in), but the odds were nil when adjusting for differences in infants characteristics.

a. Randomized controlled trial: RCT; Quasi-experimental: QE
b. LPI: Late Preterm Infant
c. Exclusive Breastfeeding: EBF; Breastfeeding: BF
d. Odds ratios (OR) and 95% Confidence Intervals (CI) were calculated if not available in papers

Table 3. Data quality assessment of included studies based on the Cochrane group methods for systematic reviews

Paper	Sequence	Treatment allocation concealment	Blinding	Completeness of outcome data	Selective outcome reporting	Other sources of bias
McKeever et al., 2002 [18]	Not mentioned	Interviewers were originally blinded to group status, but mothers later revealed their status. Baseline measurements were taken before randomization.	Did not mention blinding during analysis but personnel assessing outcomes were not adequately blinded throughout.	No differences between those who declined to participate and those who completed. Exclusions discussed but did not discuss if there were differences in those who were lost to follow up compared to included.	No	Restricted inclusion criteria make the results less generalizable to LPI: -Not experienced c-sections or postpartum complications -Babies at least 35 weeks gestation, no morbidities including hyperbilirubinemia -Included sample are mainly white, middle class.
Maastrup et al., 2021[19]	Not applicable	No concealment. Control group data was collected between October 2016 to July 2017 (pre-intervention) and intervention data between February 2018 to December 2018 (post-intervention)	Did not mention blinding during analysis but staff assessing outcomes were not blinded due to study design	High percentage of missing data. Consent was obtained for 72% and 65% of eligible participants and information on breastfeeding outcome was collected for 53% and 48% of participants in the control and intervention groups, respectively.	No	Quasi-experimental design that was conducted in different periods.

Paper	Sequence	Treatment allocation concealment	Blinding	Completeness of outcome data	Selective outcome reporting	Other sources of bias
Jang & Ju, 2020 [20]	Not applicable	No concealment, control group data was collected between 2014 and 2015 and intervention data between 2015 and 2016	Did not mention blinding during analysis but researchers assessing outcomes were not blinded due to study design	Only 3 participants were lost to follow up in the control group, unclear if there were differences in those who were not followed up with.	No	Quasi-experimental design that was conducted in different periods (1 year gap). Control group had a higher proportion of 34 weekers (48.1% vs 23.1%) whereas the experimental group had a higher proportion of 36 weeks' gestation (53.8% vs 29.6%).
Jang & Ko, 2021 [21]	Not applicable	No concealment, control group data was collected from June to October 2017 and intervention data from November 2017 to May 2018. Did not mention how the mothers and infants were allocated to each group.	Did not mention blinding during analysis but researchers assessing outcomes were not blinded due to study design	Data seems to be complete. Not clear if any participants were excluded.	No	Quasi-experimental design that was conducted in different periods The rate of ventilator used in the experimental group was higher than in the control, whereas the mean 1-minute and 5-minute Apgar scores were lower in the experimental group.
Jang & Hong, 2020 [22]	Not applicable	No concealment. Did not mention how the mothers and infants were allocated to each group, or why it wasn't a randomized controlled trial.	Did not mention blinding during analysis but researchers assessing outcomes were not blinded due to study design	Data seems to be complete. Not clear if any participants were excluded or if any data was not collected.	No	Control group had a higher proportion of infants with feeding intolerance (25% vs 10%), or an illness/complication (65% vs 50%), and who initiated feeding on a day after the day of birth (25% vs 10%).

Paper	Sequence	Treatment allocation concealment	Blinding	Completeness of outcome data	Selective outcome reporting	Other sources of bias
Estalella et al, 2020 [23]	Not applicable	No concealment, control group data was collected between 2012 and 2013 and intervention data between 2014 and 2015 (after implementation of intervention)	Did not mention blinding during analysis but personnel assessing outcomes were not blinded due to study design	Only 6 participants were excluded for refusing to participate. No attrition but data collected from medical records so missing values are possible. It was not clear which values might be missing.	No	Quasi-experimental design that was conducted in different periods. However, baseline pregnancy and delivery characteristics were not significantly different.
Abouelfettoh et al, 2008 [24]	Not applicable	No concealment. Did not mention how the mothers and infants were allocated to each group.	Did not mention blinding during analysis but researchers assessing outcomes were not blinded due to study design	High risk of bias as only the results from the first week were reported and the plan was to investigate breastfeeding practices at 1-6 weeks post-discharge. High number of attrition but the differences in characteristics of participants who remained and lost to follow-up were not investigated.	Yes	Birthweight was significantly higher in the cup-feeding group compared to the bottle-feeding group at baseline, which was not accounted for. Unclear if mothers were expressing breast milk, and if there were differences in milk expression between the two groups.

Paper	Sequence	Treatment allocation concealment	Blinding	Completeness of outcome data	Selective outcome reporting	Other sources of bias
Jang, 2020 [25]	Not applicable	No concealment, control group data was collected from June to October 2017 and intervention data from November 2017 to May 2018. Did not mention how the mothers and infants were allocated to each group.	Did not mention blinding during analysis but researchers assessing outcomes were not blinded due to study design	Data seems to be complete. Not clear if any participants were excluded.	No	Quasi-experimental design that was conducted in different periods. The length of hospital stay was significantly longer in the experimental group, and more LPI in the experimental group had diseases.
Dani et al., 2022 [26]	Not applicable	No concealment, control group data was collected from January 2018 to December 2020 at hospital 1 and intervention data from July 2019 to December 2020 at hospital 2.	Did not mention blinding during analysis but researchers assessing outcomes were not blinded due to study design	Data seems to be complete.	No	Study was conducted in different periods and settings. Gestational age was lower and the need for respiratory support was higher in hospital 2 (intervention), whereas in hospital 1 (control) there was higher need of peripheral vascular catheters and higher incidence of gestational diabetes.