# No Single Feeding Method was Universally Superior Across All Clinical Outcomes during the Transition from Gavage to Oral Feeding in Preterm Infants

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## ABSTRACT
Feeding difficulties are a major cause of prolonged hospitalization and delayed discharge among preterm infants in neonatal intensive care units. Although multiple feeding methods have been introduced to support the transition from gavage feeding to oral feeding, evidence regarding their comparative effectiveness remains inconsistent. This systematic review aimed to compare the effectiveness of different feeding methods used during the transition from gavage feeding to oral feeding in preterm infants, and to determine how each method influences physiological stability, feeding performance, and breastfeeding outcomes. This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Searches were conducted in PubMed, ScienceDirect, ProQuest, Scopus, and EBSCOhost for study publications between 2010 and 2025. Randomized controlled trials and quasi-experimental study designs were included, and methodological quality was assessed using Joanna Briggs Institute appraisal tools. Nine studies involving 1,065 preterm infants were included. Paced bottle feeding with elevated side-lying positioning improved coordination of sucking, swallowing, and breathing. Cup feeding supported higher exclusive breastfeeding rates after discharge. Syringe feeding accelerated the transition to full breastfeeding and promoted greater physiological stability. Finger feeding reduced feeding-related complications but required longer feeding time. Novel teat systems and supplemental feeding tube devices showed encouraging results, although evidence remained limited. No single feeding method demonstrated consistent superiority across all outcomes. Feeding strategies should be individualized according to infants' physiological readiness, clinical stability, breastfeeding goals, and available neonatal intensive care unit resources.
**Keywords:** preterm infants; oral feeding; cup feeding; syringe feeding; finger feeding; paced bottle feeding

## INTRODUCTION
Preterm birth remains a major global health challenge, with an estimated 13.4 million preterm infants born each year worldwide [1]. Feeding difficulties are among the most frequent and clinically significant complications encountered during hospitalization in neonatal intensive care units (NICUs). These difficulties substantially contribute to prolonged hospital stays, delayed discharge, and are a common cause of readmission, particularly among late-preterm infants who represent the largest proportion of preterm births [2–4]. Feeding problems typically manifest as ineffective oral feeding, poor tolerance to enteral feeding, and delays in achieving full oral feeding, all of which may impede the transition from gavage to independent feeding [4–7]. Importantly, unresolved feeding issues may persist after discharge and negatively affect growth trajectories, neurodevelopmental outcomes, and breastfeeding success [7,8].

Compared with term infants, preterm infants are significantly more likely to experience feeding difficulties related to oromotor immaturity and feeding behavior disorders [7,9]. The most prominent risk factors include low gestational age and low birth weight, both of which are strongly associated with delayed feeding readiness. Additional potential contributors include sex, prolonged mechanical ventilation, and extended use of orogastric tubes (OGT), which may interfere with the development of coordinated sucking and swallowing skills [10].

A wide range of feeding methods; such as cup feeding, finger feeding, syringe feeding, paced bottle feeding, supplemental feeding tube devices (SFTD), and novel teat systems have been introduced to support the transition from gavage to oral feeding in preterm infants. However, despite their widespread use, comparative evidence on the effectiveness of these methods remains limited, and clinical practice often varies across NICUs. This gap highlights the need for a systematic synthesis of available study to guide evidence-based neonatal feeding strategies.

Therefore, this review aims to compare the effectiveness of various feeding methods used during the transition from gavage to oral feeding in preterm infants, with the goal of informing clinical decision-making and improving feeding outcomes in this vulnerable population.

## METHODS
### Data sources and searches
This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [11]. The literature search was performed between January and March 2025 across five electronic databases: PubMed, ScienceDirect, ProQuest, Scopus, and EBSCOhost. A total of 7,625 articles were identified using a predefined search strategy that incorporated the following keywords: ("cup feeding" OR "bottle feeding" OR "finger feeding" OR "syringe feeding") AND (preterm OR premature) AND ("time of oral feeding" OR "time to oral feeding" OR "transition"). This systematic review was not prospectively registered in PROSPERO.

### Study selection
All randomized controlled trials (RCTs) and quasi-experimental study were included if they met the following criteria: (1) participants were preterm infants without complications (<37 weeks of gestation), both male and female; (2) interventions involved various feeding methods during the transitional feeding phase; (3) study were published in English; (4) publication years ranged from 2010 to 2025; and (5) outcomes included the effectiveness of feeding methods in: (a) accelerating the transition to oral feeding; (b) improving sucking success; (c) promoting weight gain; (d) reducing the risk of aspiration; (e) affecting oxygen saturation and heart rate; and (f) other related outcomes.

Study involving oromotor stimulation interventions such as PIOMI, non-nutritive sucking (NNS), and kangaroo mother care (KMC) were excluded. A total of 7,625 articles were identified across the five databases. After removing duplicates and applying database filters, 486 articles remained. Of these, 465 articles were excluded because their titles and abstracts were not relevant to this review, leaving 21 study for screening. Among these, 11 study were excluded due to unavailable full texts. Ultimately, 9 study met all eligibility criteria. The entire study selection process is illustrated in Figure 1.

## Data extraction and risk of bias assessment

All randomized controlled trials (RCTs) and quasi-experimental study included in this review were independently extracted by the first author (RPS) and the second author (AA). Methodological quality was critically appraised using the Joanna Briggs Institute (JBI) critical appraisal tools, specifically the JBI revised checklist for randomized controlled trials and the JBI revised checklist for quasi-experimental study. These tools consist of 13 items for RCTs and 9 items for quasi-experimental study, covering domains related to internal validity and statistical conclusion validity.

Each "yes" response was assigned a score of 1, whereas responses of "no," "unclear," or "not applicable" were assigned a score of 0 [12]. Total scores were converted into percentages based on the maximum possible score. Study scoring ≥70% were categorized as high quality, study scoring 50%–70% as moderate quality, and study scoring <50% were classified as low quality and excluded from the analysis [13].

## Treatment outcomes

This review evaluated the effectiveness of various feeding methods; including cup feeding, finger feeding, syringe feeding, paced bottle feeding, supplemental feeding tube devices (SFTD), and novel teat feeding on the following outcomes: (1) transition time to oral feeding, (2) breastfeeding outcome, (3) physiological parameters (swallowing–breathing coordination, heart rate, and $SpO_2$), (4) weight gain, and (5) length of hospital stay (LOS).

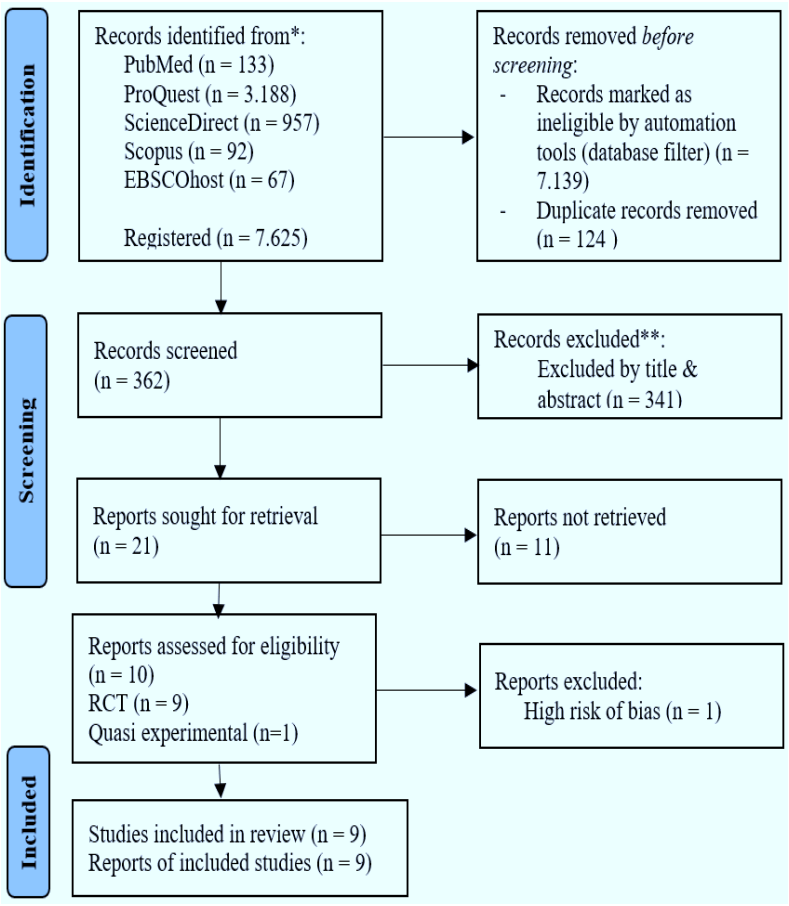


Figure 1. PRISMA flow diagram

## Data analysis

This systematic review employed a narrative synthesis approach, in which statistical findings were reported without conducting a meta-analysis. This approach was selected due to the heterogeneity of methods and variables among the included study.

# RESULTS

## Study characteristics

A total of 1,065 preterm infants were included across the nine studies in this systematic review, with individual study sample sizes ranging from 17 to 522 participants (Table 1). All infants were in the transitional phase from gavage feeding to oral feeding and received feeding interventions during hospitalization in the neonatal intensive care unit. The feeding methods evaluated included cup feeding in five studies, one of which specifically compared the Nifty Cup with a medicine cup; finger feeding in three studies; syringe feeding in two studies; and bottle feeding in four studies, including one study that examined paced bottle feeding combined with the elevated side-lying position. In addition, one study evaluated supplemental feeding tube devices, and one study investigated a novel teat system. The gestational age of the included preterm infants ranged from 25.9 to 36 weeks, with postmenstrual age ranging from 32.7 to 39.9 weeks. Among the nine studies, three were conducted in Turkey, two in Brazil, and one each in Germany, Ethiopia, Australia, and Iran.

## Transition time to oral feeding

Three studies evaluated the effectiveness of feeding methods in accelerating the transition to full oral feeding. Syringe feeding demonstrated a significantly shorter transition time to full breastfeeding compared with bottle feeding ($p = 0.002$) [14]. Meanwhile, cup feeding and supplemental feeding tube devices showed clinically favorable trends toward faster oral feeding transition; however, these findings were not statistically significant [15,16].

## Breastfeeding outcomes

Four studies assessed breastfeeding outcomes. Cup feeding significantly improved exclusive breastfeeding rates at discharge (72% vs 46%; RR 1.58, 95% CI 1.36–1.83, $p < 0.0001$), at three months after discharge (77% vs 47%; RR 1.64, 95% CI 1.42–1.89, $p < 0.0001$), and at six months after discharge (57% vs 42%; RR 1.36, 95% CI 1.14–1.63, $p < 0.001$) compared with bottle feeding [17]. Syringe feeding also demonstrated higher LATCH breastfeeding scores than bottle feeding across multiple assessments [14]. The novel teat system mimics natural breastfeeding at the mother's breast, increases milk intake, enhances milk transfer rate, and shortens sucking duration [18].

## Physiological stability and suck–swallow–breath coordination

Two studies assessed suck–swallow–breath coordination. Paced bottle feeding combined with the elevated side-lying position significantly improved coordination by reducing choking episodes, coughing, and prolonged breathing pauses [19]. Novel teat systems also demonstrated feeding patterns that more closely resembled direct breastfeeding and reduced aspiration-related risks [18]. Among the four studies evaluating physiological stability parameters; including oxygen saturation and heart rate most did not find significant differences in these outcomes [15,20,21].

However, Şengün and Şener (2022) reported a significant difference in heart rate during feeding in the syringe feeding group compared with the bottle feeding group (137.3 ± 8.5 vs 143.3 ± 10.5; t = −2.47; p = 0.016) [14].

## Weight gain and length of stay

Most studies reported no significant differences in daily weight gain between feeding methods [15–17,21]. Similarly, length of hospital stay did not differ significantly across interventions [16,17], although finger feeding was associated with shorter hospitalization duration in one study [20]. If you want, I can also prepare Table 1 in Academic English, expand this section for journal submission, or integrate it into the Results chapter.

Table 1. Characteristics of the included studies

| Author(s) | Title | Participants | Methods | Outcomes | Main finding |
|---|---|---|---|---|---|
| Hübl et al. (2025), Germany | Effect of feeding in elevated side-lying and paced bottle feeding on swallow-breathe coordination in healthy preterm infants | N: 40<br>I: 20<br>C: 20<br><br>Preterm infants with a postmenstrual age (PMA) of 34–35 weeks | Design: RCT<br><br>Measurement instrument:<br>a non-invasive measurement device integrating bioimpedance, surface electromyography, and a breathing belt. | Swallow–breath coordination | Elevated side-lying vs. elevated supine position<br>• Preterm infants fed in the elevated side-lying position experienced fewer choking and coughing episodes compared with those fed in the supine position (p = 0.03).<br>• The duration of breathing pauses was shorter in the elevated side-lying position (p = 0.026 for breathing pauses >3 seconds).<br>• Swallowing patterns were more stable in the elevated side-lying position (p = 0.04 for variability in laryngeal movement and pharyngeal closure). Paced bottle feeding vs. non-paced bottle feeding<br>• The implementation of paced bottle feeding significantly reduced the frequency and duration of breathing pauses >3 seconds (p = 0.007 for the number of breathing pauses; p = 0.024 for the total duration of breathing pauses).<br>• The number of swallowing movements per burst was lower during paced bottle feeding (p = 0.02). |
| Yilmaz et al. (2014) Turkey | Effect of cup feeding and bottle feeding on breastfeeding in late preterm infants: a randomized controlled study | N: 522<br>Cup: 254<br>Bottle: 268<br><br>Preterm infants with a gestational age of 32–35 weeks who were fed exclusively through intermittent gastric tube feeding. | Design: RCT<br><br>Measurement instruments: weighing scale and length of stay (LOS) records. | • Exclusive breastfeeding success<br>• Body weight<br>• Length of hospital stay (LOS) | Exclusive Breastfeeding at Discharge<br>• Cup feeding method: 72%<br>• Bottle feeding method: 46%<br>• Relative Risk (RR): 1.58 (95% CI: 1.36–1.83, p < 0.0001)<br>Exclusive Breastfeeding at 3 Months Post-Discharge<br>• Cup feeding method: 77%<br>• Bottle feeding method: 47%<br>• RR: 1.64 (95% CI: 1.42–1.89, p < 0.0001)<br>Exclusive Breastfeeding at 6 Months Post-Discharge<br>• Cup feeding method: 57%<br>• Bottle feeding method: 42%<br>• RR: 1.36 (95% CI: 1.14–1.63, p < 0.001)<br>Length of Hospital Stay<br>• Cup feeding method: 25.7 ± 2.2 days<br>• Bottle feeding method: 25.9 ± 2.2 days<br>• p = 0.15 (not significant)<br>Weight Gain During the First 7 Days<br>• Cup feeding method: 16.7 ± 1.5 g/day<br>• Bottle feeding method: 16.8 ± 1.5 g/day<br>• p = 0.64 (not significant) |
| Alinezhad Shebilouysofla et al. (2022), Iran | Effect of cup, syringe, and finger feeding on time of oral feeding of preterm neonate's: a randomized controlled clinical trial | N: 99<br>Cup: 33<br>Syringe: 33<br>Finger feeding: 33<br><br>Preterm infants with gestational age of 30-34 weeks | Design: RCT<br><br>Measurement instruments: daily body weight measurement, oxygen saturation monitoring, heart rate monitoring, and recording of apnea and bradycardia events. | • Time to achieve full oral feeding<br>• Daily weight gain<br>• Changes in physiological status (heart rate and $SpO_2$) | Time to Achieve Full Oral Feeding<br>• There was no significant difference in the mean time required to achieve full oral feeding among the three methods (p = 0.652).<br>Daily Weight Gain<br>• No significant difference in daily weight gain was observed among the groups (p = 0.127).<br>Oxygen Saturation ($SaO_2$) and Heart Rate<br>• No significant difference in post-feeding oxygen saturation was found among the three groups (p = 0.337).<br>• Post-feeding heart rate did not differ significantly among the groups (p = 0.233); however, the |

| Author(s) | Title | Participants | Methods | Outcomes | Main finding |
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| | | | | | syringe feeding group showed a slightly higher heart rate compared with the cup feeding group ($p = 0.026$).<br>Adverse Events<br>• No cases of apnea were reported in any of the three groups.<br>• Bradycardia occurred in one infant in the syringe feeding group.<br>• Choking episodes occurred in:<br>- Cup feeding group: 13 infants<br>- Finger feeding group: 11 infants<br>- Syringe feeding group: 14 infants (slightly higher than the other methods). |
| Nunes et al. (2019), Brazil | Oxygen saturation and heart rate in premature: comparison between cup and finger feeding techniques | N: 25<br>Cup: 8<br>Finger feeding: 17<br><br>Preterm infants with getational age of 35-36 weeks | Design: RCT<br><br>Measurement instrument:<br>a pulse oximeter used to measure oxygen saturation and heart rate before, during, and after feeding. | • Oxygen saturation<br>• Heart rate<br>• Body weight<br>• Length of hospital stay | Oxygen Saturation<br>• No significant differences were observed before, during, and after feeding in either group ($p > 0.05$ in the Friedman test and Generalized Estimating Equations [GEE] analysis).<br>Heart Rate (HR)<br>• Significant differences were observed only on days 4, 8, and 10 in the cup feeding group and on days 5 and 7 in the finger feeding group ($p < 0.05$ according to Dunn's post-hoc test).<br>Body Weight<br>• Significant weight gain was observed in both groups ($p = 0.012$ for the cup feeding group and $p = 0.001$ for the finger feeding group based on the Wilcoxon test).<br>Length of Hospital Stay<br>• Finger feeding was associated with a shorter hospital stay, although no significant differences were found in the main physiological parameters. |
| Şengun & Şener (2022), Turkey | The effect of feeding methods of bottle and injector on the transition to full breastfeeding and sucking success in preterm newborns: A randomized controlled trial. | N: 62<br>Bottle: 31<br>Syringe: 31<br><br>Preterm infants with gestational age of 28-36 weeks | Design: RCT<br><br>Measurement instrument:<br>LATCH *Breastfeeding Diagnostic Scale* | • Transition time to full breastfeeding<br>• LATCH score<br>• Body weight at discharge<br>• Physiological status | • The time to achieve full breastfeeding was shorter in the syringe feeding group compared with the bottle feeding group ($p = 0.002$).<br>• The time to achieve full oral feeding did not differ significantly between groups ($p = 0.294$).<br>• LATCH scores were higher in the syringe feeding group at the initial assessment ($p = 0.001$), after 48 hours ($p < 0.001$), and prior to discharge ($p < 0.001$).<br>• Heart rate during feeding was more stable in the syringe feeding group compared with the bottle feeding group ($p = 0.016$), as it did not significantly increase infants' heart rate during feeding.<br>• No significant differences were observed in weight gain, respiratory rate, and $SpO_2$ outcomes. |
| Moreira et al. (2017), Brazil | Comparison of the finger feeding versus cup feeding methods in the transition from gastric to oral feeding in preterm infants. | N: 53<br>Cup: 27<br>Finger feeding: 26<br><br>Preterm infants with gestational age of 32-34 weeks | Design: RCT non blinded and longitudinal<br><br>Measurement instruments:<br>Gauze pads<br>A weighing scale with 0.1 g sensitivity, A video recorder | • Milk loss<br>• Feeding duration<br>• Complications during feeding | • Milk loss was lower in the finger feeding group compared with the cup feeding group, particularly among infants with a gestational age of 32–34 weeks ($p = 0.001$).<br>• Feeding duration was longer in the finger feeding group than in the cup feeding group; however, this method allowed infants to control milk flow more effectively ($p = 0.26$).<br>• The frequency of complications was lower in the finger feeding group compared with the cup feeding group among infants with a gestational age of 32–34 weeks ($p = 0.001$).<br>• No significant difference in weight gain was observed between the two methods ($p = 0.34$). |

| Author(s) | Title | Participants | Methods | Outcomes | Main finding |
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| İncekar et al. (2021), Turkey | An alternative supplemental feeding method for preterm infants: the supplemental feeding tube device | N: 46<br>SFTD: 23<br>Bottle: 23<br><br>preterm infants with PMA of 34 weeks | Design: RCT<br><br>Measurement instrument:<br>LATCH *breastfeeding assessment tool* | • Weight gain<br>• Breastfeeding success (LATCH)<br>• Length of hospital stay<br>• Time to transition to full breastfeeding | • SFTD and bottle feeding demonstrated similar effectiveness in terms of weight gain ($p > 0.05$), breastfeeding success ($p = 0.413$), and length of hospital stay ($p > 0.05$).<br>• Infants in the SFTD group transitioned to full breastfeeding more rapidly than those in the bottle feeding group, although the difference was not statistically significant ($p > 0.05$).<br>• Most mothers in the SFTD group were satisfied with the method, although some reported that the device was difficult to use. |
| Geddes et al. (2018), Australia | Preterm infant feeding: A mechanistic comparison between a vacuum triggered novel teat and breastfeeding | Seventeen mothers and preterm infants with a gestational age of 23.6–33.3 weeks and a postmenstrual age (PMA) ranging from 32.7 to 39.9 weeks. | Design: RCT<br><br>Measurement instruments:<br><br>Submental ultrasonography to assess tongue movement and intraoral pressure during feeding,<br>An intraoral pressure measuring device,<br>A weighing scale,<br>Pulse oximetry equipment | • Volume of milk consumed<br>• Intraoral vacuum<br>• Milk transfer rate<br>• Sucking duration | • The novel teat increased the volume of milk consumed by infants compared with direct breastfeeding ($p = 0.007$).<br>• Intraoral vacuum was lower when infants used the novel teat compared with direct breastfeeding ($p < 0.001$).<br>• The milk transfer rate was higher with the novel teat than with direct breastfeeding ($p < 0.001$).<br>• Sucking duration was shorter when using the novel teat ($p = 0.027$), although it did not affect the total feeding duration ($p = 0.28$). |
| McKinney et al.(2019), Ethiopia | A randomized crossover trial comparing the Nifty cup to a medicine cup in preterm infants who have difficulty breastfeeding at Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana | Mothers of preterm infant<br>N: 200<br>NC: 101<br>MC: 99<br><br>Preterm infants<br>N: 237<br>NC: 122<br>MC: 115<br><br>Preterm infants in the NICU aged at least 24 hours, with a gestational age of <37 weeks. | Design: RCT<br><br>Measurement instruments:<br>A 5-point Likert scale,<br>Infant bibs,<br>A digital clock | • Maternal preference<br>• Spillage<br>• Feeding duration | Maternal Preference:<br>• Eighty-five percent of mothers preferred the Nifty Cup, compared with 57% who preferred the medicine cup ($p < 0.001$).<br>• Seventy-five percent of mothers selected the Nifty Cup as the better feeding method ($p < 0.001$).<br>Spillage Rate:<br>• The Nifty Cup had a mean spillage rate of 8.9%, whereas the medicine cup had a spillage rate of 9.3%.<br>• The difference was not statistically significant ($p = 0.35$); however, mothers reported greater comfort when using the Nifty Cup.<br>Confidence and Ease of Use:<br>• Mothers reported greater confidence and ease of use with the Nifty Cup compared with the medicine cup ($p < 0.001$).<br>• One month after hospital discharge, 70% of mothers continued using the Nifty Cup to feed their infants. |

# DISCUSSION

The findings of this systematic review indicate that no single feeding method demonstrated superiority across all clinical outcomes. However, several interventions showed specific advantages related to feeding efficiency, breastfeeding success, physiological stability, and feeding safety. These findings emphasize the importance of individualized feeding strategies based on infants' developmental readiness, physiological stability, and breastfeeding goals.

## Transition to oral feeding

The findings of this review suggest that syringe feeding may facilitate a faster transition to full breastfeeding compared with conventional bottle feeding [14]. This advantage may be associated with the ability of syringe feeding to minimize nipple confusion and preserve breastfeeding-related oral motor patterns during early feeding transition. Previous neonatal feeding literature has emphasized that feeding approaches supporting physiological oral motor development may contribute to earlier feeding maturation in preterm infants [22]. Similarly, finger feeding and supplemental feeding methods may enhance oral sensory stimulation and support neuromuscular coordination required for successful oral feeding acquisition [23].

Although cup feeding and supplemental feeding tube devices demonstrated clinically favorable trends toward shorter oral feeding transition times, statistical significance was not consistently achieved across studies. This inconsistency may reflect differences in gestational age, feeding readiness, intervention protocols, and sample size among included studies. Feeding transition in preterm infants is a multifactorial developmental process influenced not only by feeding technique but also by neurological maturation, respiratory stability, and behavioral organization [24].

## Breastfeeding outcomes

One of the most consistent findings in this review was the positive effect of cup feeding on exclusive breastfeeding continuation after hospital discharge. Infants receiving cup feeding demonstrated significantly higher exclusive breastfeeding rates at discharge and during follow-up periods compared with bottle-fed infants [17]. These findings align with a previous systematic review by McKinney and colleagues, which reported that cup feeding increased the likelihood of breastfeeding among mothers who intended to breastfeed [25]. The World Health Organization also recommends alternative feeding methods, including cup feeding, for infants who are temporarily unable to breastfeed directly while breastfeeding establishment is still desired [26].

Syringe feeding also demonstrated favorable breastfeeding outcomes through significantly higher LATCH breastfeeding scores compared with bottle feeding [14]. Similarly, the novel teat system evaluated in this review appeared to mimic physiological breastfeeding patterns by improving milk transfer while reducing sucking effort [18]. Mechanistically, feeding devices that more closely resemble breastfeeding may better support oral motor coordination and breastfeeding self-regulation in preterm infants with immature feeding skills [10].

## Physiological stability and suck–swallow–breath coordination

Feeding safety and physiological stability are critical considerations during oral feeding transition in preterm infants because immature suck–swallow–breath coordination increases the risk of aspiration, oxygen desaturation, and feeding-related cardiorespiratory instability [27]. In this review, paced bottle feeding combined with elevated side-lying positioning significantly improved suck–swallow–breath coordination by reducing choking episodes, coughing, and prolonged breathing pauses [19]. These findings support previous evidence indicating that side-lying positioning may improve respiratory regulation and feeding organization by slowing milk flow and allowing infants greater control over swallowing and breathing coordination [28].

Novel teat systems also demonstrated feeding patterns that more closely resembled direct breastfeeding and potentially reduced aspiration-related risks [18]. These findings are physiologically plausible because vacuum-triggered feeding systems require infants to actively generate negative intraoral pressure, similar to direct breastfeeding mechanics. Such mechanisms may help promote safer swallowing coordination and reduce feeding stress in preterm infants [18].

Most included studies did not identify significant differences in oxygen saturation or heart rate between feeding methods, suggesting that the evaluated interventions were generally physiologically safe in clinically stable preterm infants [15,20,21]. However, syringe feeding demonstrated significantly different heart rate responses during feeding compared with bottle feeding [14]. Increased heart rate during feeding may reflect higher feeding effort or stress associated with immature oral motor coordination. Therefore, close physiological monitoring remains important during implementation of alternative feeding interventions in vulnerable preterm populations.

## Weight gain and length of hospital stay

This review did not identify consistent differences in weight gain or length of hospital stay between feeding methods. These findings suggest that nutritional growth and hospitalization outcomes in preterm infants are influenced by multiple interacting factors beyond feeding technique alone, including medical comorbidities, gestational maturity, caloric intake adequacy, infection risk, and overall physiological stability [5]. Although one study reported shorter hospitalization duration among infants receiving finger feeding, the limited number of studies and methodological heterogeneity prevent definitive conclusions regarding its effectiveness in reducing hospital stay duration.

## Clinical implications

The findings of this review have important implications for neonatal intensive care unit clinical practice. Cup feeding may be considered when the primary goal is to support exclusive breastfeeding continuation after discharge. Paced bottle feeding combined with elevated side-lying positioning may improve feeding safety among preterm infants with immature suck–swallow–breath coordination. Meanwhile, syringe feeding and finger feeding may serve as transitional feeding approaches for infants with limited sucking ability during early oral feeding development. Importantly, feeding selection should remain individualized according to infants' physiological readiness, breastfeeding goals, caregiver competency, and resource availability within neonatal intensive care unit settings.

## Strengths and limitations

This review provides a comprehensive synthesis of multiple feeding methods used during oral feeding transition in preterm infants, including emerging interventions such as paced bottle feeding, supplemental feeding tube devices, and novel teat systems. The inclusion of randomized controlled trials and quasi-experimental studies strengthened the methodological rigor of the review.

However, several limitations should be acknowledged. Considerable heterogeneity existed across studies regarding gestational age, feeding protocols, outcome measurements, and intervention duration. The relatively small number of studies evaluating several interventions also limited direct comparison between feeding methods. Furthermore, meta-analysis could not be performed because of methodological variability and inconsistent outcome reporting across studies. Future multicenter randomized controlled trials with standardized outcome measures are needed to establish stronger evidence regarding optimal feeding strategies for preterm infants.

# CONCLUSION

The review showed that no single feeding method was consistently superior across all clinical outcomes during the transition from gavage feeding to oral feeding in preterm infants. Cup feeding supported better continuation of exclusive breastfeeding, while syringe feeding appeared to facilitate a faster transition to full breastfeeding. Paced bottle feeding with elevated side-lying positioning improved suck–swallow–breath coordination and feeding safety. Novel teat systems and supplemental feeding tube devices also showed potential in promoting physiological feeding patterns, although current evidence remains limited. Overall, feeding approaches in neonatal intensive care units should be tailored to each infant's physiological readiness, breastfeeding goals, and clinical condition, and further high-quality multicenter studies are needed to strengthen the evidence base.

## Ethical consideration, competing interest and source of funding

-Although this review did not require formal ethical certification, all processes adhered to essential ethical principles by ensuring transparency, accuracy, and reliance solely on previously published studies that had obtained approval from their respective ethics committees.
-There is no conflict of interest related to this research.
-Source of funding is authors.

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