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Impact of colostrum combined with non-nutritive sucking in non-invasive ventilated very low birth weight preterm infant

Yanfen Tong[1], Yingying Chen[1], MaDing Zhao[1], Qingqing Li[1*] and Shenhui Jin[2*]

Abstract

Background Feeding intolerance is a common challenge in very low birth weight (VLBW) preterm infants undergoing non-invasive ventilation (NIV). While colostrum and non-nutritive sucking (NNS) have shown promise in improving feeding outcomes individually, their combined effect remains unclear. This study aims to evaluate the impact of colostrum administration alongside NNS on the feeding status of VLBW preterm infants receiving NIV.

Methods This retrospective observational study was conducted in the NICU at the Second Affiliated Hospital of Wenzhou Medical University from June 2020 to June 2022. Feeding outcomes analyzed included initiation and complete feeding times, birth weight recovery, total enteral nutrition time, incidence of feeding intolerance, and length of hospital stay.

Results A total of 163 VLBW infants on NIV were included, categorized into four groups: control ($n=43$), colostrum ($n=40$), NNS ($n=42$), and colostrum + NNS ($n=38$). The colostrum + NNS group experienced significantly shorter times to initiate oral feeding (217.15 ± 1.20 days vs. 222.10 ± 1.15 days, $P<0.05$), achieve complete oral feeding (233.15 ± 1.55 days vs. 241.20 ± 1.83 days, $P<0.05$), regain birth weight (8.01 ± 1.68 vs. 11.21 ± 2.57 days, $P<0.05$), and reach total enteral nutrition (11.09 ± 2.14 vs. 15.77 ± 2.30 days, $P<0.05$). The incidence of feeding intolerance was lower (23.68% vs. 41.86%, $P<0.05$), and hospital stay was reduced (48.13 ± 11.76 vs. 57.42 ± 14.94 days, $P<0.05$).

Conclusions The combination of colostrum and NNS may improve feeding outcomes in VLBW infants receiving NIV, leading to earlier feeding milestones and reduced feeding intolerance. Further randomized controlled trials are needed to confirm these findings and assess long-term effects.

Keywords Very low birth weight infant, Non-Nutritive sucking, Colostrum, Feeding intolerance, Premature infant, Non-Invasive ventilation, Neonatal intensive care

*Correspondence:
Qingqing Li
892743578@qq.com
Shenhui Jin
491452861@qq.com
[1]Department of neonatal intensive care unit (NICU), the Second Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, China
[2]Department of anesthesiology, the First Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, China

Background

The advancements in perinatal medicine have significantly improved the survival rates of preterm infants. However, very low birth weight infants (VLBWIs)—defined as preterm neonates with a birth weight under 1500 g [1]—continue to face high mortality rates despite medical progress [2]. Among the challenges affecting their survival and recovery, feeding intolerance (FI) is a major concern, impacting up to 63.2% of VLBWIs [3]. F FI delays the initiation of oral feeding and the transition to total enteral nutrition, leading to prolonged hospitalization, increased healthcare costs, and heightened risks of complications such as anemia, metabolic imbalances, cholestasis, and necrotizing enterocolitis (NEC) [3, 4].

One of the primary contributors to feeding difficulties in VLBWIs is respiratory distress syndrome (RDS), a common condition that often necessitates non-invasive ventilation (NIV) [5]. While NIV provides essential respiratory support, it can negatively impact gastrointestinal function, further exacerbating FI. Specifically, NIV may contribute to aerophagia (swallowing of air), increased intra-abdominal pressure, and altered esophageal sphincter function, all of which can lead to abdominal distension, delayed gastric emptying, and gastroesophageal reflux [6, 7]. These factors create additional barriers to the establishment of enteral feeding and highlight the need for effective interventions to mitigate FI in this population [8–10].

Several strategies have been explored to improve feeding tolerance in preterm infants, including colostrum administration and non-nutritive sucking (NNS). Colostrum, the nutrient-rich first milk produced postpartum, contains bioactive molecules that support gastrointestinal maturation, immune regulation, and microbial defense, thereby lowering the risk of NEC and ventilator-associated pneumonia (VAP) [11–13]. Studies have shown that oropharyngeal administration of colostrum can enhance feeding readiness and tolerance, promoting a smoother transition to oral feeding [14]. Similarly, NNS, a rhythmic sucking activity without milk intake, has been found to stimulate sucking-swallowing coordination, enhance gut motility, and trigger the release of digestive hormones, thereby accelerating the transition to full oral feeding [15, 16].

Although the individual benefits of colostrum and NNS are well-documented, their combined impact on feeding outcomes in VLBWIs is still unclear. This study hypothesizes that the distinct yet complementary mechanisms of colostrum and NNS may work synergistically to improve feeding efficiency, reduce feeding intolerance, and accelerate recovery in VLBWIs receiving NIV. By addressing this gap, the study aims to provide evidence-based recommendations for enhancing nutritional management in NICUs, ultimately optimizing care and outcomes for preterm infants.

Methods

Study design and participants

This retrospective observational study took place in the neonatal intensive care unit (NICU) at the Second Affiliated Hospital of Wenzhou Medical University from June 2020 to June 2022. The study received approval from the hospital's ethics committee (Approval Number: 2024-YL-115-01), and written informed consent was obtained from the parents of all participants prior to randomization.

The study included preterm neonates with birth weights between 1000 g and 1499 g who required non-invasive ventilation (NIV) after birth. Exclusion criteria included: (1) congenital heart disease; (2) esophagotracheal fistula requiring surgery; (3) active maternal tuberculosis or AIDS; (4) ongoing radioisotope therapy; (5) any condition preventing continuous provision of colostrum for seven days; and (6) infants whose mothers experienced interruptions in breastfeeding. Collected colostrum was either immediately transported to the NICU for use or stored in a medical refrigerator for no longer than 24 h if immediate administration was not feasible.

Intervention

Participants were divided into four groups: (1) Control Group: Received daily oral care with normal saline. (2) Colostrum Group: Received 0.2 ml of preheated colostrum via a sterile syringe. The colostrum was administered slowly in 0.1 ml doses to each side of the oropharynx, with 15–20 s pauses between drops to facilitate absorption. This procedure was repeated eight times daily for seven days. (3) NNS Group: Used a sterilized, non-porous rubber pacifier for non-nutritive sucking. Infants sucked for five minutes every three hours, eight times daily for seven days. (4) Colostrum + NNS Group: Received 0.2 ml of preheated colostrum applied to a sterilized pacifier, with infants sucking on the pacifier for five minutes every three hours, eight times daily for seven days.

All groups received the same enteral and parenteral nutrition, adhering to the Chinese Practical Neonatology guidelines for the nutritional management of premature infants. Feeding schedules were determined by physicians based on individual clinical conditions. Interventions were stopped immediately if adverse reactions such as nausea, vomiting, apnea, bradycardia, or decreased oxygen saturation occurred.

Table 1 Comparison of clinical data among the four groups

	Control group ($n=43$)	Colostrum group ($n=40$)	NNS group ($n=42$)	Colostrum +NNS group ($n=38$)	*P*
Gender					
Male	23 (53%)	18 (45%)	21 (50%)	21 (55%)	0.81
Female	20 (47%)	22 (55%)	21 (50%)	17 (45%)	
Gestational age (weeks)	30.59 ± 1.21	30.68 ± 1.58	30.63 ± 1.31	30.34 ± 1.75	0.73
Birth head circumference (cm)	28.92 ± 2.06	28.24 ± 2.35	28.31 ± 1.79	28.74 ± 2.09	0.38
Delivery mode					
Spontaneous labor	15 (36%)	15 (38%)	17 (40%)	13 (34%)	0.93
Cesarean section	28 (64%)	25 (62%)	25 (60%)	25(66%)	
Birth length (cm)	37.54 ± 2.51	36.91 ± 3.73	37.24 ± 3.37	36.77 ± 2.91	0.69
Birth weight (g)	1286.7 ± 197.2	1287.4 ± 212.5	1213.3 ± 201.5	1267 ± 207.5	0.31
1 min Apgar Score(IQR)	8(7,9)	8(7,9)	8(7,9)	8(7.9)	0.71
5 min Apgar score(IQR)	9(8,9)	9(8,9)	9(8,9)	9(8,9)	0.83

Table 2 Comparison of feeding status among the four groups

	Control group ($n=43$)	Colostrum group ($n=40$)	Colostrum +NNS group ($n=38$)	NNS group ($n=42$)	*P*
Time to start oral feeding (days)	236.10 ± 1.10	222.10 ± 1.15[be]	217.15 ± 1.20[cd]	227.90 ± 1.15[a]	*<0.05
Complete oral feeding duration (days)	248.85 ± 1.50	241.20 ± 1.83[b]	233.15 ± 1.55[cd]	240.75 ± 1.82[a]	*<0.05
Time to regain birth weight (days)	11.21 ± 2.57	9.65 ± 2.29[b]	8.01 ± 1.68[cd]	9.53 ± 2.15[a]	*<0.01
Reach total enteral nutrition time (days)	15.77 ± 2.3	13.52 ± 2.27[b]	11.09 ± 2.14[cd]	12.56 ± 1.98[a]	*<0.01

*$P < 0.05$

[a]Compared with control group, $P < 0.05$

[b]Compared with control group; $P < 0.05$

[c]Compared with colostrum group, $P < 0.05$

[d]Compared with NNS group, $P < 0.05$

[e]Compared with NNS group, $P < 0.05$

Outcomes

The primary outcome was feeding intolerance, defined according to the 2020 Clinical Guidelines for the Diagnosis and Treatment of Feeding Intolerance in Premature Infants [17, 18]. Secondary Outcomes included feeding status indicators: time to initiate oral feeding, time to achieve total enteral nutrition, time to reach full oral feeding, birth weight recovery time, feeding rates (at initiation, day 7, and at full oral feeding), and length of hospital stay.

Data analysis

Data were analyzed using Stata 15 software. Continuous data with a normal distribution were expressed as mean ± standard deviation, and the Shapiro-Wilk test was used to confirm normality. One-way analysis of variance (ANOVA) was performed to compare continuous data among the four groups, followed by Bonferroni post-hoc analysis for inter-group comparisons. Categorical variables were presented as counts (percentages) and were analyzed using Chi-square tests. Repeated measures ANOVA assessed feeding efficiency across time points. A P-value of < 0.05 was considered statistically significant.

Results

A total of 176 very low birth weight infants (VLBWIs) were initially included in the study. Thirteen infants were excluded due to loss to follow-up or other reasons, leaving 163 participants for analysis. Baseline characteristics, including sex ratio, gestational age, birth weight, head circumference, mode of delivery, and Apgar scores at 1 and 5 min, showed no significant differences among the four groups ($P > 0.05$; Table 1).

The time to initiate oral feeding was significantly shorter in the colostrum group (31.71 ± 1.17 weeks) and the non-nutritive sucking (NNS) group (32.55 ± 1.11 weeks) compared to the control group (33.59 ± 1.12 weeks; both $P < 0.05$). The colostrum + NNS group had the earliest initiation time (31.02 ± 1.28 weeks), significantly earlier than both the colostrum ($P = 0.016$) and NNS ($P = 0.034$) groups (Table 2). Similarly, the time to complete oral feeding was significantly shorter in both the colostrum (34.46 ± 1.82 weeks) and NNS (34.38 ± 1.91 weeks) groups compared to the control group (35.55 ± 1.71 weeks; both $P < 0.05$). The colostrum + NNS group achieved full oral feeding the fastest (33.31 ± 1.56 weeks), significantly earlier than both the colostrum ($P < 0.05$) and NNS ($P < 0.05$) groups.

Table 3 Comparison of feeding efficiency at different time points in the four groups

	Rate at initiation of oral feeding (ml/min)	Rate at 7th day after initiation of oral feeding (ml/min)	Rate up to full oral feeding (ml/min)	*P*
Control group	2.98 ± 1.45	4.48 ± 1.66	8.18 ± 4.92	*<0.01
Colostrum group	4.12 ± 1.87[a]	7.79 ± 2.77[a]	11.43 ± 4.51[a]	
Colostrum +NNS group	4.97 ± 1.58[cd]	8.89 ± 3.35[cd]	13.57 ± 5.32[cd]	
NNS group	3.57 ± 1.56[b]	7.17 ± 4.07[b]	10.19 ± 4.57[b]	
P	*<0.05	*<0.05	*0.04	

*$P < 0.05$

[a]Compared with control group, $P < 0.05$

[b]Compared with control group; $P < 0.05$

[c]Compared with colostrum group, $P < 0.05$

[d]Compared with NNS group, $P < 0.05$

The time to regain birth weight was shortest in the colostrum + NNS group (8.01 ± 1.68 days), significantly shorter than the colostrum ($P = 0.007$) and NNS ($P = 0.01$) groups. Both the colostrum (9.65 ± 2.29 days) and NNS (9.53 ± 2.15 days) groups showed faster weight recovery compared to the control group (11.21 ± 2.57 days; both $P < 0.05$). The time to achieve total enteral nutrition was also significantly shorter in the colostrum group (13.52 ± 2.27 days) and the NNS group (12.56 ± 1.98 days) compared to the control group (15.77 ± 2.30 days; both $P < 0.001$). The colostrum + NNS group demonstrated the fastest transition (11.09 ± 2.14 days), significantly faster than both the colostrum ($P < 0.001$) and NNS ($P = 0.02$) groups.

At the initiation of oral feeding, feeding rates were higher in the colostrum (4.12 ± 1.87 ml/min, $P < 0.05$) and NNS groups (3.57 ± 1.56 ml/min, $P < 0.05$) compared to the control group (2.98 ± 1.45 ml/min). The colostrum + NNS group achieved the highest feeding rate (4.97 ± 1.58 ml/min), significantly higher than both the colostrum ($P = 0.001$) and NNS ($P = 0.001$) groups (Table 3). By day 7, feeding rates in the colostrum (7.79 ± 2.77 ml/min, $P < 0.05$) and NNS groups (7.17 ± 4.07 ml/min, $P < 0.05$) remained higher than in the control group (4.48 ± 1.66 ml/min). The colostrum + NNS group showed the highest rate (8.89 ± 3.35 ml/min), significantly higher than both the colostrum ($P < 0.05$) and NNS ($P < 0.05$) groups. At full oral feeding, the colostrum + NNS group had the highest feeding rate (13.57 ± 5.32 ml/min), significantly higher than the colostrum (11.43 ± 4.51 ml/min, $P < 0.05$) and NNS (10.19 ± 4.57 ml/min, $P < 0.05$) groups. Both intervention groups outperformed the control group (8.18 ± 4.92 ml/min, $P < 0.05$).

The colostrum + NNS group had the shortest hospital stay (48.13 ± 11.76 days), significantly shorter than both the control group (57.42 ± 14.94 days, $P = 0.009$) and the NNS group (55.32 ± 12.76 days, $P = 0.034$) (Table 4).

Discussion

This study shows that combining NNS with colostrum significantly enhances feeding outcomes for VLBWIs receiving non-invasive ventilation NIV. The colostrum + NNS group had the shortest times to initiate and complete oral feeding, regain birth weight, and achieve total enteral nutrition compared to the groups receiving colostrum alone, NNS alone, or standard care. Furthermore, this group demonstrated the highest feeding efficiency at all time points and experienced a significantly shorter hospital stay.

NNS is a well-documented intervention that enhances oral feeding skills in preterm infants by promoting the coordination of sucking, swallowing, and breathing while also stimulating gastrointestinal hormone secretion [19]. Studies have shown that NNS accelerates the transition from tube to oral feeding, shortens hospital stays, and reduces feeding intolerance [15, 19, 20]. In our study, the NNS group demonstrated significantly earlier achievement of total enteral nutrition and higher feeding rates at full oral feeding. Additionally, NNS was associated with fewer feeding-related complications, such as gastric residue and abdominal distension, consistent with previous research [21, 22].

Colostrum, the first milk produced postpartum, is rich in bioactive compounds that promote gastrointestinal maturation, immune regulation, and microbial defense [23–25]. It has been shown to reduce the risk of necrotizing enterocolitis (NEC) and feeding intolerance in preterm infants [26]. Previous studies have demonstrated

Table 4 Comparison of duration of non-invasive mechanical ventilation and length of hospital stays among the four groups

	Control group ($n = 43$)	Colostrum group ($n = 40$)	Colostrum +NNS group ($n = 38$)	NNS group ($n = 42$)	*P*
Duration of non-invasive mechanical ventilation (days)	10.02 ± 4.92	11.97 ± 5.12	12.25 ± 5.65	11.32 ± 4.76	0.19
Length of stay (days)	57.42 ± 14.94	50.07 ± 12.09	48.13 ± 11.76[ab]	56.34 ± 14.39	0.004

*$P < 0.05$

[a]Compared with control group, $P < 0.05$

[b]Compared with NNS group, $P < 0.05$

that oropharyngeal administration of colostrum enhances feeding tolerance and accelerates the transition to oral feeding [27]. In our study, the colostrum group showed a significantly shorter time to initiate oral feeding and a lower incidence of feeding intolerance (37.5%), further supporting its role in improving feeding outcomes in VLBWIs.

Our study provides novel evidence that combining colostrum with NNS enhances feeding efficiency beyond the benefits of each intervention alone. The colostrum + NNS group outperformed all other groups in feeding-related outcomes, with a feeding intolerance incidence as low as 23.68%. This synergistic effect may be attributed to the stimulation of oropharyngeal sensory pathways by NNS, which enhances the absorption of bioactive molecules in colostrum, thereby promoting gastrointestinal motility and reducing feeding-related complications [28, 29].

Given these findings, integrating colostrum administration and NNS as a combined intervention into routine NICU feeding protocols could be a low-cost, non-invasive strategy to optimize feeding outcomes in VLBWIs. Practical implementation in the NICU setting could involve early initiation of NNS using a pacifier, regular oropharyngeal administration of colostrum, and the combination of colostrum with NNS by applying colostrum to a pacifier to enhance both oral sensory stimulation and bioactive compound absorption. Additionally, individualized assessment of feeding readiness should be incorporated to determine the optimal timing for transitioning to oral feeding, ensuring that the intervention is tailored to each infant's clinical condition.

Despite its strengths, this study has several limitations. First, the retrospective design may introduce biases due to reliance on existing medical records and potential confounding factors. Future randomized controlled trials (RCTs) are needed to confirm these findings and establish causality. Second, as a single-center study, the results may not be fully generalizable to other NICUs, where feeding protocols, maternal colostrum availability, and neonatal care practices may differ. Multicenter studies are necessary to validate these findings across diverse clinical settings. Additionally, individual differences in feeding tolerance must be considered, as responses to colostrum and NNS can vary based on gestational age, comorbidities, and gastrointestinal maturity. Incorporating personalized feeding strategies that adjust interventions based on individual infant needs may further optimize outcomes. Another limitation is that this study primarily focused on short-term feeding outcomes and hospital stay, without assessing long-term impacts on growth trajectories, neurodevelopment, or overall health. Future research should include follow-up studies to determine whether the short-term benefits observed translate into long-term improvements in preterm infant development. Finally, while this study suggests a synergistic effect of colostrum and NNS, the underlying physiological and biochemical mechanisms remain unclear. Further investigation is required to elucidate how NNS enhances colostrum absorption and its potential interaction with neurohormonal pathways and gastrointestinal motility.

Conclusion

This study demonstrates the significant advantages of combining colostrum and NNS as a novel, non-invasive method to enhance feeding outcomes in VLBWIs. This combined approach not only shortened the time needed to reach crucial feeding milestones but also improved feeding rates and decreased hospital stays. These results provide compelling evidence for integrating colostrum and NNS into the standard care for preterm infants. Future research should aim to confirm these findings through randomized controlled trials, investigate the mechanisms behind the synergistic effects, and assess long-term outcomes such as growth and neurodevelopment. By adopting this combined strategy, NICUs can improve clinical outcomes, minimize complications related to feeding intolerance, and optimize healthcare resources for this vulnerable population.

Abbreviations

VLBW	Very low birth weight
NIV	Non-invasive ventilation
NNS	Non-nutritive sucking
FI	Feeding intolerance
NEC	Necrotizing enterocolitis
VAP	Ventilator-associated pneumonia
ANOVA	Analysis of variance
NNS	Non-nutritive sucking
RTCs	Randomized controlled trials

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Not applicable.

Authors' contributions

Yanfen Tong, Dingma Zhao and Qingqing Li collected the clinical data and data analysis; Yanfen Tong, Yingying Chen and Shenhui Jin contributed to the interpretation of data and reviewed and edited the article and approved the final draft.

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Data availability

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Second Affiliated Hospital of Wenzhou Medical University (Approval Number: 2024-YL-115-01). Since the medical information of the VLBW infants was used in this study, their parents were informed about the study protocol and provided written informed consent for their participation. I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Tang Z, Zhou Y, Li MX. Clinical features of feeding intolerance in preterm infants. Zhongguo Dang Dai Er Ke Za Zhi. 2011;13:627–30.
2. Sharrow D, Hug L, You D, Alkema L, Black R, Cousens S, et al. Global, regional, and National trends in under-5 mortality between 1990 and 2019 with scenario-based projections until 2030: a systematic analysis by the UN Inter-agency group for child mortality Estimation. Lancet Glob Health. 2022;10:e195–206.
3. Jadcherla SR, Kliegman RM. Studies of feeding intolerance in very low birth weight infants: definition and significance. Pediatrics. 2002;109:516–7.
4. Yang Q, Kong J, Bai RM, Yu WT, Zhang J, Shen W, et al. Effects of mixed oil emulsion on short-term clinical outcomes in premature infants: a prospective, multicenter, randomized controlled trial. Eur J Clin Nutr. 2023;77:823–32.
5. Hasan SU, Lodha AK, Yusuf K, Dalgleish S. Physiological basis of neonatal aerodigestive difficulties in chronic lung disease. Clin Perinatol. 2020;47:277–99.
6. Cresi F, Maggiora E, Lista G, Dani C, Borgione SM, Spada E, et al. Effect of nasal continuous positive airway pressure vs heated humidified high-flow nasal cannula on feeding intolerance in preterm infants with respiratory distress syndrome: the ENTARES randomized clinical trial. JAMA Netw Open. 2023;6:e2323052.
7. Havranek T, Madramootoo C, Carver JD. Nasal continuous positive airway pressure affects pre- and postprandial intestinal blood flow velocity in preterm infants. J Perinatol. 2007;27:704–8.
8. Yi YG, Oh BM, Shin SH, Shin JY, Kim EK, Shin HI. Stress signals during sucking activity are associated with longer transition time to full oral feeding in premature infants. Front Pediatr. 2018;6:54.
9. Ghomi H, Yadegari F, Soleimani F, Knoll BL, Noroozi M, Mazouri A. The effects of premature infant oral motor intervention (PIOMI) on oral feeding of preterm infants: a randomized clinical trial. Int J Pediatr Otorhinolaryngol. 2019;120:202–9.
10. Dutta S, Singh B, Chessell L, Wilson J, Janes M, McDonald K, et al. Guidelines for feeding very low birth weight infants. Nutrients. 2015;7:423–42.
11. Castellote C, Casillas R, Ramírez-Santana C, Pérez-Cano FJ, Castell M, Moretones MG, et al. Premature delivery influences the immunological composition of colostrum and transitional and mature human milk. J Nutr. 2011;141:1181–7.
12. Corpeleijn WE, van Vliet I, de Gast-Bakker DA, van der Schoor SR, Alles MS, Hoijer M, et al. Effect of enteral IGF-1 supplementation on feeding tolerance, growth, and gut permeability in enterally fed premature neonates. J Pediatr Gastroenterol Nutr. 2008;46:184–90.
13. Chen XC, Tong YF, Han ZM, Lin ZL. The effects of early oropharyngeal administration of microdosed colostrum on feeding status in ventilated extremely low-birth-weight infants. Breastfeed Med. 2021;16(8):648–53.
14. Nasuf AWA, Ojha S, Dorling J. Oropharyngeal colostrum in preventing mortality and morbidity in preterm infants. Cochrane Database Syst Rev. 2018;9:Cd011921.
15. Khodagholi Z, Zarifian T, Soleimani F, Khoshnood Shariati M, Bakhshi E. The effect of non-nutritive sucking and maternal milk odor on the independent oral feeding in preterm infants. Iran J Child Neurol. 2018;12:55–64.
16. Fujitsuka M, Takao K, Ueki S, Morokuma AQS. Early introduction of oral feeding and its impact on full oral feeding and discharge in preterm infants: a systematic review protocol. JBI Evid Synth. 2025. https://doi.org/10.11124/JBIES-24-00169.
17. Evidence-Based Medicine Group NS, Association CMD [Clinical guidelines for the. Diagnosis and treatment of feeding intolerance in preterm infants (2020)]. Zhong guo Dang Dai Er Ke Za Zhi. 2020;22:1047–55.
18. Dollberg S, Kuint J, Mazkereth R, Mimouni FB. Feeding tolerance in preterm infants: randomized trial of bolus and continuous feeding. J Am Coll Nutr. 2000;19:797–800.
19. Foster JP, Psaila K, Patterson T. Non-nutritive sucking for increasing physiologic stability and nutrition in preterm infants. Cochrane Database Syst Rev. 2016;10:Cd001071.
20. Zhang Y, Lyu T, Hu X, Shi P, Cao Y, Latour JM. Effect of nonnutritive sucking and oral stimulation on feeding performance in preterm infants: a randomized controlled trial. Pediatr Crit Care Med. 2014;15:608–14.
21. Boyle EM, Freer Y, Khan-Orakzai Z, Watkinson M, Wright E, Ainsworth JR, et al. Sucrose and non-nutritive sucking for the relief of pain in screening for retinopathy of prematurity: a randomised controlled trial. Arch Dis Child Fetal Neonatal Ed. 2006;91:F166–8.
22. Pinelli J, Symington A. Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants. Cochrane Database Syst Rev. 2005:CD001071.
23. Yong G, Fang H, ShuangGen M, Guocheng X. Effect of bifid triple viable on feeding intolerance in preterm infants with very low birth weight. Chin J Microecology. 2009;21:451–2.
24. Isolauri E, Salminen S. The impact of early gut microbiota modulation on the risk of child disease: alert to accuracy in probiotic studies. Benef Microbes. 2015;6:167–71.
25. Vaarala O, Atkinson MA, Neu J. The perfect storm for type 1 diabetes: the complex interplay between intestinal microbiota, gut permeability, and mucosal immunity. Diabetes. 2008;57:2555–62.
26. da Cruz Martins C, de Santana Xavier Ramos M, Viana Cardoso Amaral M, Santos Passos Costa J, Souza Cerqueira E, de Oliveira Vieira T, et al. Colostrum oropharyngeal immunotherapy for very low birth weight preterm infants: protocol of an intervention study. BMC Pediatr. 2020;20: 371.
27. Huo M, Liu C, Mei H, Zhang Y, Liu C, Song D, et al. Intervention effect of oropharyngeal administration of colostrum in preterm infants: a meta-analysis. Front Pediatr. 2022;10:895375.
28. Li Q, Tan X, Li X, Tang W, Mei L, Cheng G, et al. Efficacy and safety of combined oral sucrose and nonnutritive sucking in pain management for infants: a systematic review and meta-analysis. PLoS One. 2022;17:e0268033.
29. Arvedson J, Clark H, Lazarus C, Schooling T, Frymark T. Evidence-based systematic review: effects of oral motor interventions on feeding and swallowing in preterm infants. American Journal of Speech-Language Pathology. 2010;19:321–40.

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