Research Article

Non-nutritive Sucking in Preterm Infants-simple Intervention with Substantial Benefits

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Abstract

Preterm birth, defined as delivery before 37 weeks of gestation, remains a leading cause of neonatal morbidity and mortality globally. One of the developmental challenges in preterm infants is the immaturity of the sucking-swallowing-breathing triad, which hinders successful oral feeding. Non-Nutritive Sucking (NNS) is an innate reflex in neonates that involves sucking motions without the intake of nutrition. This behaviour, often facilitated by pacifiers or a gloved finger, plays a vital role in neurodevelopment, feeding maturity, and physiological regulation in preterm infants. Recent studies also highlight its psychological and lactational benefits for mothers. This review presents a synthesis of current evidence supporting NNS as a low-cost, non-invasive intervention with multidimensional benefits for both preterm infants and their mothers.

Introduction

Preterm birth—defined by the World Health Organization as birth before 37 completed weeks of gestation—affects approximately 15 million infants globally each year and is a major contributor to neonatal morbidity and mortality. One of the critical developmental challenges faced by preterm neonates is the immaturity of their oral feeding mechanisms. In particular, the coordination of sucking, swallowing, and breathing—a triad essential for safe and efficient oral feeding—may not fully develop until around 34 - 36 weeks of gestation. As a result, many preterm infants require tube feeding in the early postnatal period, leading to delayed oral feeding milestones, prolonged hospitalization, and increased parental stress.

Non-Nutritive Sucking (NNS) is an innate reflex in newborns characteriszed by sucking movements not associated with fluid intake. It can be facilitated through the use of pacifiers, gloved fingers, or an empty breast. NNS typically emerges between 28 and 32 weeks of gestational age and matures in coordination with the swallowing reflex. Numerous studies have demonstrated that NNS can play a crucial role in accelerating the acquisition of oral feeding skills by stimulating the oro-motor system, modulating physiological responses,

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and promoting gastrointestinal motility. Furthermore, NNS offers psychosensory comfort and pain relief during stressful or invasive procedures and supports the neurobehavioral development of preterm infants.

In addition to its physiological benefits for infants, NNS has demonstrated a positive impact on maternal lactation and emotional bonding. Mothers who engage in at-breast NNS with their infants experience increased oxytocin release, enhanced milk ejection reflexes, and greater confidence in breastfeeding. The act of comforting and nurturing through NNS may also promote maternal-infant bonding and reduce the emotional burden of Neonatal Intensive Care Unit (NICU) admission.

This paper reviews the current evidence on the clinical, developmental, and psychological benefits of non-nutritive sucking in preterm infants and explores its implications for neonatal care practices and maternal well-being.

Physiological and developmental benefits of NNS in preterm infants

Non-nutritive sucking has been shown to stimulate the oro-motor system, which is crucial for the coordination of sucking and swallowing. It accelerates the development of



the sucking reflex and improves feeding performance and weight gain in preterm infants [1]. NNS significantly enhances gastric motility and promotes earlier transition from tube to oral feeding [2]. Infants engaging in NNS demonstrate better oxygen saturation levels and fewer episodes of bradycardia and apnea [3]. Moreover, NNS is associated with increased vagal tone, promoting parasympathetic activity and improved gastrointestinal function [4]. A meta-analysis by Pinelli and Symington [5] revealed that NNS significantly reduced the time to full oral feeding and the length of hospital stay, making it a cost-effective intervention in Neonatal Intensive Care Units (NICUs). Recent studies also suggest that NNS positively influences gut hormone release, including gastrin and motilin, which further supports digestion and nutrient absorption. The repetitive motion of sucking may enhance central pattern generator activation in the brainstem, thereby supporting the maturation of rhythmic sucking behaviours. Additionally, NNS has been correlated with improved behavioural state regulation, enabling infants to remain in quiet alert states during feeding readiness assessments. Preterm neonates receiving NNS exhibit more coordinated swallowing and reduced aspiration risks during the transition to oral feeds. This behavioural intervention is also known to stimulate facial musculature development, contributing to long-term oral motor skills essential for speech and feeding. Clinical protocols that incorporate NNS into developmental care pathways have reported earlier discharge dates without compromising growth outcomes. Furthermore, regular NNS sessions have been found to lower salivary cortisol levels, indicating reduced stress during hospitalization. Hospitals implementing NNS as a standard NICU practice often report improved parental satisfaction and bonding experiences, especially when parents are taught to participate in the intervention.

Neurodevelopmental outcomes and pain modulation

NNS is thought to promote neurobehavioral organization by offering comforting and self-soothing effects. It plays a role in stress reduction and improved behavioural state regulation [6]. Through mechanisms involving endogenous opioid release, NNS has been found to reduce the behavioural response to painful stimuli during procedures such as heel pricks [7]. Functional MRI studies suggest that oro-sensory experiences such as NNS contribute to enhanced brain activity in regions responsible for sensorimotor integration [8]. Additionally, NNS has been associated with faster development of sleep-wake cycling and more time spent in quiet sleep, which is crucial for neural development. Preterm infants exposed to regular NNS interventions show increased alertness and responsiveness to environmental stimuli, facilitating early interaction and learning. This neurosensory stimulation may contribute to improved synaptogenesis during critical periods of brain maturation. NNS also appears to modulate the Hypothalamic-Pituitary-Adrenal (HPA) axis, helping attenuate excessive stress hormone release in the NICU environment. Several studies have reported improved Brazelton Neonatal Behavioural Assessment Scale (NBAS) scores in infants who received consistent NNS exposure. Furthermore, early NNS interventions have been linked to better scores on developmental indices during early infancy, including cognitive and motor domains assessed by tools like the Bayley Scales of Infant Development.

Heterogeneity in Study Outcomes -Efficacy across gestational ages. Meta-analysis by Zhao, et al. 2024 [9] (18 RCTs; n = 1,250) demonstrated a mean reduction of 3.1 days to full oral feeds (95 % CI 2.2 - 4.0) but substantial heterogeneity ($l^2 = 65$ %). Sub-group analysis revealed larger benefits in infants \geq 30 weeks compared with those < 28 weeks. Variations in length of stay. Tsai, et al. 2024 [10] focused on extremely preterm (< 28 w) cohorts and reported modest, non-significant reductions in NICU stay (-2.0 days; 95 % CI -5.1 - 1.1). Differences were attributed to respiratory-support burden and delayed NNS initiation.

Influence of NICU Practices - Modality matters. A network meta-analysis by Lu, et al. 2025 [11] ranked at-breast NNS combined with kangaroo care as having the highest probability of shortening hospital stay and improving exclusive-breastfeeding rates. Pacifier-based NNS performed best for analgesia during procedures, whereas gloved-finger NNS was favoured when parental involvement was limited. 'Dose' and timing. Studies initiating NNS before 30 weeks corrected age and delivering ≥5 sessions per day reported stronger neurodevelopmental gains. Unit policies that paired NNS with motivational interviewing for parents achieved higher adherence.

Persisting evidence gaps

- Limited long-term neurodevelopmental follow-up beyond two years.
- Sparse data in humanitarian or low-income settings where pacifier access is constrained.
- Under-representation of maternal psychological and lactational endpoints only 28% of RCTs captured validated maternal-stress scales.

Benefits to mothers: Lactation and bonding

Non-nutritive sucking not only provides a bridge to support the development of oral feeding skills, regulate infant physiology but also potentially improve maternal-infant bonding and lactation outcomes. The presence of the mother during NNS, particularly when performed at the breast, enhances oxytocin secretion and supports milk ejection reflexes [12]. Early NNS at the breast, even in the absence of milk, can help preterm infants develop a positive association with breastfeeding, leading to increased breastfeeding rates post-discharge [13]. Furthermore, mothers report enhanced bonding and emotional satisfaction when they are actively involved in their infant's oral care through NNS, including



kangaroo care combined with suckling stimulation [14]. Oxytocin release associated with at-breast NNS not only facilitates lactation but also has calming effects on maternal physiology, reducing stress and anxiety levels. This interaction creates a neuroendocrine feedback loop that strengthens the maternal-infant dyad during a critical period of attachment. Mothers who engage in skin-to-skin contact and breast-based NNS often experience improved confidence in their caregiving abilities, leading to more frequent and sustained breastfeeding efforts. Involving mothers in such practices can also help alleviate feelings of helplessness and disempowerment that are commonly reported in NICU settings. Studies have shown that maternal voice, touch, and scent-combined with NNScan significantly modulate the infant's behavioural responses and promote synchrony in mother-infant interactions. The act of at-breast NNS may also stimulate the release of prolactin, thereby supporting long-term milk production and enhancing maternal readiness for nutritive breastfeeding once the infant is physiologically prepared. Finally, mothers involved in NNS interventions report higher satisfaction with neonatal care services and a deeper emotional connection to their infant, which are crucial determinants of long-term maternal mental health and infant developmental outcomes.

Regular at-breast NNS amplifies pulsatile oxytocin release, augmenting milk-ejection reflexes and cumulative milk volume [9]. Programmes that integrate structured maternal-education modules and bedside coaching have halved time to first successful nutritive breast-feed compared with standard care. Implementation strategies shown to be effective include: (i) designating an 'NNS champion' nurse per shift; (ii) using brief video demonstrations in multiple languages; and (iii) embedding NNS prompts within electronic feeding charts. These strategies not only improve intervention fidelity but also enhance maternal self-efficacy and reduce Edinburgh Postnatal Depression Scale scores by up to 3 points [11] (Table 1).

Clinical implications and recommendations

Given its proven benefits, NNS should be integrated as a standard supportive care practice in NICUs. Key recommendations include:

- Introduction of NNS using a pacifier or gloved finger as early as 28 30 weeks corrected gestational age.
- Encouragement of at-breast NNS in medically stable preterm infants to support breastfeeding.
- Education for NICU staff and parents about the role and timing of NNS.
- Adopt family-centred NNS protocols that start by 28 -30 weeks gestation, prioritise at-breast modality where feasible, and deliver ≥ 5 daily sessions.
- Embed maternal-outcome monitoring (milk-volume logs, stress scales) as routine quality-improvement metrics.
- Implementation playbook. Dedicate staff champions, leverage multilingual multimedia resources, and integrate NNS prompts into electronic records (Table 2).

| Table 2: Overview of Outcomes, Practices, and Evidence Gaps. | | | |
|--|---|---|--|
| Dimension | Key Variations | Implications | |
| Study outcomes | Time to full oral feeds (-1 to -5 days); length of stay (-0 to -7 days); breastfeeding at discharge (15% - 20%) | Need for gestational-age-specific protocols and consistent outcome definitions | |
| NICU practices | Pacifier vs. at-breast vs. gloved-finger; session frequency; parental involvement | Standardised training and decision algorithms can reduce heterogeneity | |
| Evidence gaps | Sparse data < 28 weeks GA; limited maternal-mental-health metrics; lack of health-economic evaluations | Future trials should adopt core outcome sets and report maternal endpoints | |

| Table 1: Pros and Cons of Non-Nutritive Sucking (NNS) for Preterm Infants and Mothers. | | | |
|--|---|---|--|
| Aspect | Pros (Benefits) | Cons (Limitations/Risks) | |
| Neurodevelopment (Infant) | - Enhances oral-motor coordination [1] - Improves readiness for oral feeding [2] - Promotes neural integration [3] | - Overuse without proper weaning may reduce self-soothing development in some cases | |
| Feeding and Nutrition (Infant) | Accelerates transition from tube to oral feeding [4] Improves sucking-swallowing-breathing coordination Enhances gastric motility [5] | - May delay nutritive feeding if misused as a substitute rather than supplement | |
| Physiological Stability | Reduces apnea and bradycardia episodes [6] Improves oxygen saturation and heart rate variability [7] | - Not recommended for critically unstable infants without monitoring | |
| Pain Modulation (Infant) | Decreases pain perception via endorphin release [8] Reduces stress response during minor procedures | - May mask signs of pain during necessary medical assessments | |
| Length of Hospital Stay | - Shortens NICU stay duration [12] - Reduces healthcare costs by promoting earlier discharge | - Variable results depending on NICU protocols and feeding readiness | |
| Breastfeeding (Mother-Infant) | Encourages pre-feeding behaviour and nipple familiarity [13] Increases breastfeeding initiation and duration rates | - May create nipple confusion if pacifier-based NNS used excessively | |
| Maternal Lactation | - Stimulates oxytocin release and supports milk let-down [14] - Enhances milk production and maternal confidence | - If done away from the breast (e.g., pacifier), may miss opportunity to stimulate lactation | |
| Emotional Bonding (Mother) | Strengthens mother-infant bonding during skin-to-skin and at-breast NNS [9] Reduces maternal stress and anxiety | - If NNS is delegated to staff or devices, may reduce mother's active participation | |
| Cost and Implementation | - Low-cost, easy-to-train intervention - Requires minimal equipment | Requires staff training and protocols for appropriate use Monitoring needed to avoid overuse or misapplication | |



Conclusion

Non-nutritive sucking is a simple, low-risk, and evidencebased intervention that offers a range of benefits for preterm infants and their mothers. It plays a pivotal role in enhancing the transition from enteral to oral feeding by promoting oromotor development, improving feeding coordination, and stimulating gastrointestinal function. Beyond its nutritional implications, NNS supports autonomic stability, modulates pain perception during routine NICU procedures, and fosters neurobehavioral development during a critical period of brain maturation. Equally important are the benefits of NNS for mothers. When incorporated into care practices such as kangaroo care or at-breast comfort sucking, NNS promotes oxytocin release and enhances lactation, which are essential for establishing successful breastfeeding. It also provides mothers with a sense of involvement and empowerment in the care of their vulnerable infants—an emotional anchor that can positively influence maternal-infant bonding and mental well-being. Despite its simplicity, the implementation of NNS must be guided by clinical protocols, appropriate timing, and individualized assessment. Contraindications such as facial anomalies or severe respiratory instability must be ruled out. Education and training of NICU staff and parents are essential to ensure its optimal use. NNS is thus both an infant-centred neuro-developmental therapy **and** a maternal-centric lactation-support strategy. Its efficacy varies with gestational age, modality and local practice, underscoring the need for standardised, family-centred implementation. Addressing current evidence gaps-especially in extremely preterm populations and maternal mental health—will unlock the full potential of this deceptively simple, high-value intervention

In summary, non-nutritive sucking is a powerful adjunctive therapy that bridges the gap between biological immaturity and functional independence in preterm infants. It embodies a holistic approach to neonatal care—addressing not just survival, but developmental progress and the emotional ecosystem of early life. Its routine use in NICUs should be strongly encouraged as part of comprehensive, family-centred developmental care. We therefore believe that non-nutritive sucking is a simple yet powerful intervention that supports preterm infant development, facilitates earlier oral feeding, modulates pain, and strengthens maternal lactation and bonding. Given its safety profile, low cost, and far-reaching benefits, NNS deserves wider implementation in neonatal care protocols across global settings.

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