"EFFECT OF BREAST MILK ODOUR ON TIME NEEDED TO ACHIEVE FULL SPOON/PALADAI FEEDING IN PRETERM BABIES-ONE YEAR HOSPITAL BASED RANDOMIZED STUDY"

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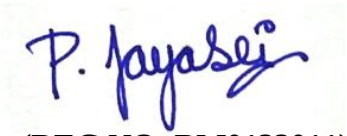

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LIST OF ABBREVIATIONS

AON – Anterior Olfactory Nucleus

AMY – Amygdala

BPD – Bronchopulmonary Dysplasia

CLASSI – Central Line Associated Blood Infection

CPAP – Continuous Positive Airway Pressure

EC – Entorhinal Cortex

EGD – Esophagogastroduodenoscopy

EUGR-Extra uterine growth restriction

FEES – Fiberoptic Endoscopic Evaluation of Swallowing

FiO_2 – Fraction of Inspired Oxygen

GCs –GABAnergic granule cells

GCS – Glasgow Coma Scale

GER – Gastroesophageal Reflux

H_2RA – Histamine-2 Receptor Antagonist

HIE – Hypoxic-Ischemic Encephalopathy

HYPO – Hypothalamus

IBM SPSS-International Business Machine Corporation Statistical package for the Social sciences

IVH – Intraventricular Hemorrhage

MC – Mitral Cells

MRI – Magnetic Resonance Imaging

NEC – Necrotizing Enterocolitis

NICU – Neonatal Intensive Care Unit

NNS – Non-Nutritive Sucking

NS – Nutritive Sucking

OB – Olfactory Bulb

OE – Olfactory Epithelium

OSN – Olfactory Sensory Neurons

OT – Olfactory Tubercle

PC – Piriform Cortex

PDA – Patent Ductus Arteriosus

PH-MII – pH Monitoring with Multichannel Intraluminal Impedance

PICC – Percutaneously Inserted Central Catheter

PIOMI – Preterm Infant Oral Motor Intervention

PIPP – Premature Infant Pain Profile

PMA – Postmenstrual Age

PPI's – Proton Pump Inhibitors

PVL – Periventricular Leukomalacia

RDS – Respiratory Distress Syndrome

ROP – Retinopathy of Prematurity

RT – Room Temperature

SD – Standard Deviation

SIP – Spontaneous Intestinal Perforation

SPSS – Statistical Package for the Social Sciences

TCs – Tufted Cells

TT – Tenia Tecta

TPN – Total Parenteral Nutrition

UA – Umbilical Artery

UGI – Upper Gastrointestinal Fluoroscopy

UV – Umbilical Vein

VFSS – Video Fluoroscopic Swallow Study

WHO – World Health Organization

ABSTRACT

"EFFECT OF BREAST MILK ODOUR ON TIME NEEDED TO ACHIEVE FULL SPOON/PALADAI FEEDING IN PRETERM BABIES - ONE YEAR HOSPITAL BASED RANDOMIZED STUDY''

Background

Preterm birth remains a major contributor to neonatal morbidity and mortality globally. One of the most common challenges faced by preterm infants is feeding difficulty due to immature coordination of sucking, swallowing, and breathing. These issues often lead to delayed achievement of full oral feeding, poor weight gain, and extended hospital stay. Olfactory stimulation using maternal breast milk odor has emerged as a non-invasive and cost-effective intervention aimed at enhancing feeding readiness by stimulating the suck reflex and promoting feeding behaviors in preterm infants.

Materials and Methods

This randomized clinical trial was conducted at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, over a one-year period (April 2023 – March 2024). A total of 98 preterm neonates (30–34 weeks gestation) were enrolled and randomized into two groups: 49 in the intervention group and 49 in the control group. The intervention group received olfactory stimulation with breast milk three times daily for seven consecutive days, with a cotton pad soaked in 1 mL of breast milk placed near the nostrils for five minutes before feeding. Both groups received standard NICU care, and outcomes measured included time to achieve full spoon feeding, weekly weight gain, and duration of hospital stay.

Results

The intervention group achieved full spoon feeding significantly earlier (mean 6.14 ± 3.52 days) compared to the control group (10.39 ± 6.22 days; $p < 0.001$). Transition time from tube to full oral feeds and length of hospital stay were also significantly shorter in the intervention group ($p < 0.001$ for both). Infants in the intervention group showed significantly less weight loss in the first week ($p < 0.001$) and greater weight gain in the second week ($p = 0.023$). However, weight differences in subsequent weeks were not statistically significant. These findings suggest that olfactory stimulation with breast milk can accelerate feeding milestones and early weight gain.

Conclusions

Breast milk odor stimulation is a safe, simple, and effective strategy to promote faster oral feeding transition in preterm infants. It not only improves feeding outcomes but also shortens hospital stay, thereby reducing healthcare costs and parental stress. Incorporating this non-pharmacological intervention into neonatal care practices can enhance the growth and development of preterm infants, though further research is needed to evaluate its long-term benefits.

Keywords: Preterm infants, breast milk odor, olfactory stimulation, oral feeding, feeding progression, neonatal care, weight gain, hospital stay.

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INTRODUCTION

Prematurity is a significant global health concern. According to the World Health Organization (WHO), preterm birth is defined as delivery before 37 weeks of gestation. In 2020, approximately 13.4 million infants were born preterm, accounting for nearly 9.9% of all births. Despite advancements in healthcare, low-income countries continue to face challenges due to limited data availability and inadequate healthcare services, making it difficult to address preterm birth effectively. Prematurity places a substantial burden on healthcare systems and families[1].

Preterm infants are born before the full development of major organ systems, including the cardiovascular, respiratory, central nervous, and gastrointestinal systems. As a result, they frequently experience respiratory distress, electrolyte imbalances, feeding difficulties, and cardiovascular complications[2].

Feeding and swallowing difficulties are particularly prevalent among preterm infants. Feeding is a complex process requiring the coordination of sucking, swallowing, and breathing. Due to neurological immaturity and underdeveloped systems, many preterm infants struggle with this coordination at birth, making direct breastfeeding challenging. Consequently, feeding difficulties can significantly impact nutritional intake, leading to poor weight gain, micronutrient deficiencies, and weakened immunity. These issues contribute to prolonged hospital stays, increased infection risks, and greater chances of complications. Therefore, expediting the transition to full oral feeding is essential in reducing hospitalization duration, associated morbidities, healthcare burden, and financial costs[3].

Several strategies have been developed to support the establishment of oral feeding in preterm infants. These include sensory and motor interventions such as oromotor stimulation, abdominal massage, tactile stimulation of the body and extremities, olfactory stimulation, and vestibular stimulation.

Among these, olfactory stimulation has emerged as a simple yet effective method for minimizing feeding difficulties in preterm infants. The sense of smell is one of the earliest to develop, functioning from the embryonic stage. Postnatally, olfactory inputs play a crucial role in digestion by activating the sucking reflex. The presence of familiar scents, such as maternal milk odor, helps trigger feeding behaviors by sending sensory signals to the brainstem and thalamus[4]. Additionally, olfactory stimulation contributes to an infant's overall comfort and well-being.

However, preterm infants who rely on tube feeding miss out on the taste and smell of breast milk. This deprivation of chemosensory exposure may hinder feeding development and delay maternal-infant bonding[5]. The extent to which the absence of olfactory interaction influences feeding challenges or bonding remains unclear. To address this gap, further research is needed to explore methods of introducing maternal milk odor to tube-fed preterm infants and evaluate its effects on feeding outcomes.

While many studies have investigated non-nutritive sucking and motor stimulation, research on olfactory stimulation remains limited. This study aims to explore the effectiveness of a simple, non-invasive, and cost-effective intervention that could help preterm infants improve their feeding abilities.

OBJECTIVES

PRIMARY:

- To determine the effect of breast milk odour on the time needed to achievement of full spoon/ paladai feeding in preterm infants.

SECONDARY :

To know the effect of breast milk odour on:

1) Transition time from tube to spoon/ paladai feeding.
2) Weekly weight gain.
3) Length of hospital stay.

REVIEW OF LITERATURE

Prematurity and its incidence

Preterm birth, as defined by the World Health Organization (WHO), refers to the birth of an infant before completing 37 weeks of gestation[1]. It poses a major global health challenge, with approximately 13.4 million preterm births reported in 2020—equating to over one in ten births, or roughly one baby born prematurely every two seconds[1]. India alone accounted for 3.02 million of these cases in 2020, with a preterm birth rate of 13.0%, representing more than 20% of all preterm births globally and ranking the highest worldwide[2]. Prematurity-related complications remain a primary cause of neonatal mortality, leading to nearly 900,000 deaths in 2019[1].

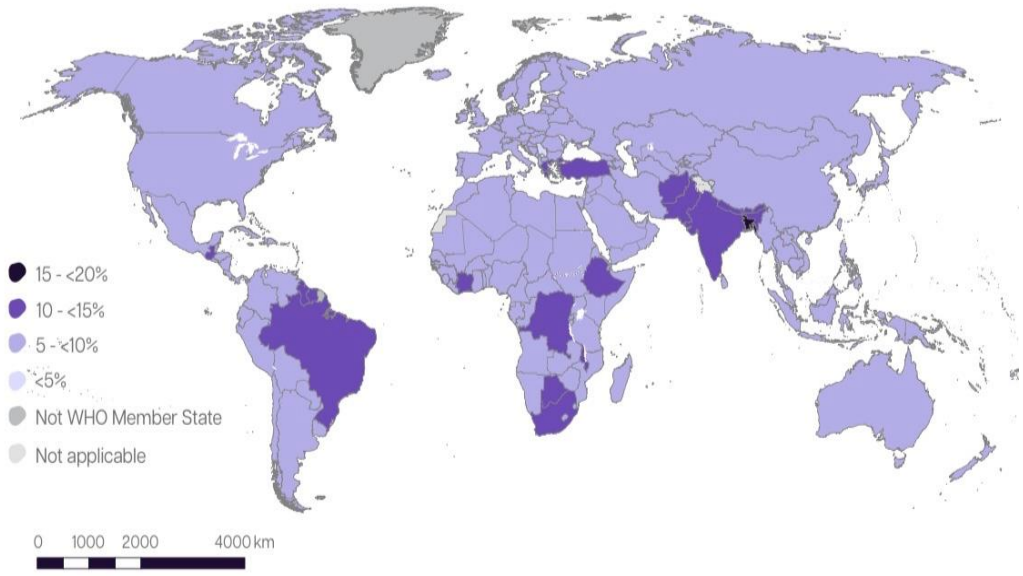

Figure 1:Estimated national preterm birth rates in 2020[2].

Hurdles faced by preterm newborns

Preterm infants encounter various difficulties after birth, such as breathing and heart-related issues, infections, and neurological concerns(Table 1)[6](Figure 2). At the same time, they must continue growing and develop essential skills needed for a safe discharge[7].

These early life adversities can disrupt critical periods of organogenesis and tissue differentiation, leading to both immediate and long term effects on fetal and preterm development [5]. Although developmental plasticity enables adaptive changes for survival,these compensatory responses may increase susceptibility to future pathological conditions [8,9].

Table -1: Health challenges linked to premature birth [6]

Category	Early Complications	Late Complications
Respiratory Issues	Respiratory Distress Syndrome (RDS), Apnea of prematurity.	Bronchopulmonary dysplasia (BPD), Recurrent hospitalizations for respiratory infections
Neurological Complications	Intraventricular hemorrhage (IVH) ,Periventricular leukomalacia (PVL)	Cerebral palsy, Motor and developmental delays, Cognitive impairments
Gastrointestinal Complications	Necrotizing enterocolitis (NEC)	Extra uterine growth restriction (EUGR), Failure to thrive and impaired catch-up growth
Cardiovascular Issues	Patent ductus arteriosus (PDA)	Heart failure and ischemic heart disease
Metabolic and Nutritional Problems	Hypoglycemia, Electrolyte imbalances, Poor feeding tolerance	Type 2 diabetes, Chronic kidney disease
Temperature Regulation	Hypothermia.	Long-term challenges in temperature regulation
Social and Behavioral Challenges	Not typically evident early	Social withdrawal, shyness, and Increased likelihood of bullying
Vision and Hearing Impairments	Not typically evident early	Retinopathy of prematurity (ROP)

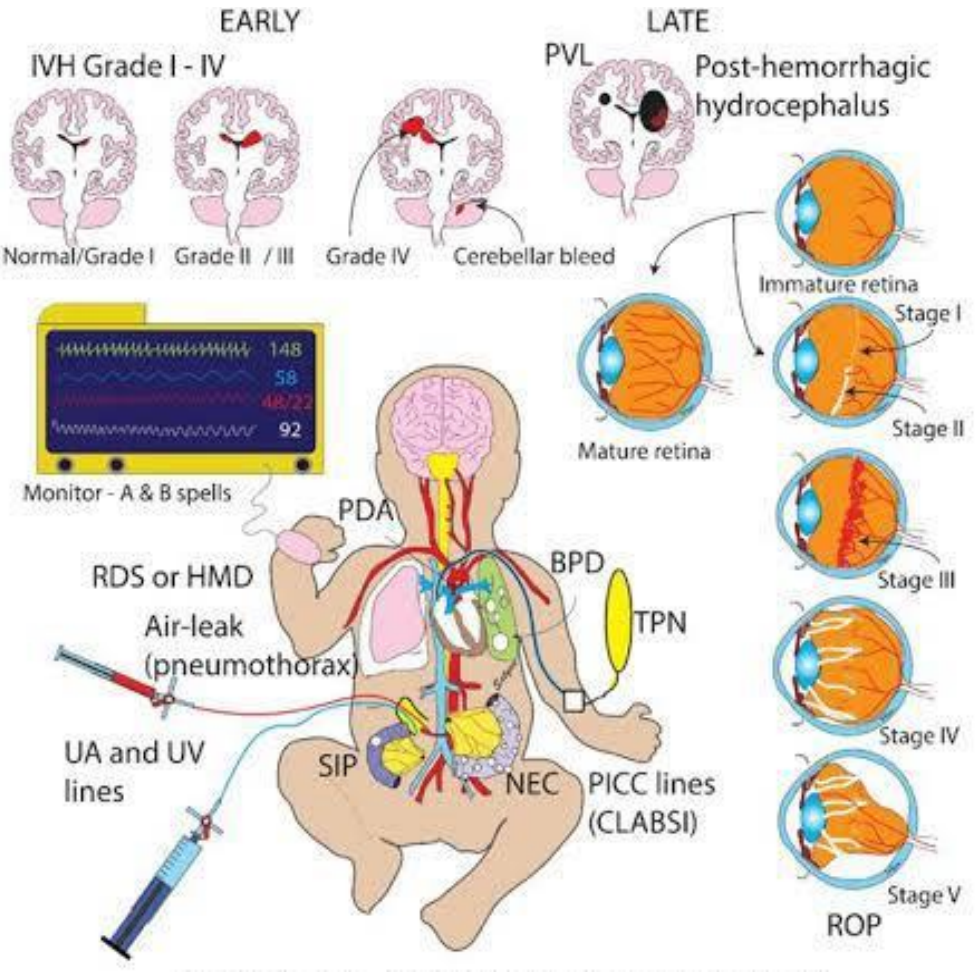

Figure 2: Early and late complications of prematurity [10]

(A & B - Apnea and bradycardia,BPD - bronchopulmonary dysplasia,CLABSI - central line associated blood infection,IVH - intraventricular hemorrhage, NEC - necrotizing enterocolitis,PDA - patent ductus arteriosus ,PICC line - percutaneously inserted central catheter,PVL - periventricular leukomalacia,RDS - respiratory distress syndrome,ROP - retinopathy of prematurity, SIP - spontaneous intestinal perforation, TPN - total parenteral nutrition,UA - umbilical artery,UV - umbilical vein)[10].

Preterm infants frequently experience the above mentioned health challenges, with feeding difficulties being a significant yet often unnoticed[7].

Physiology of Feeding

Babies begin developing their sucking and swallowing abilities before birth. Around 11-12 weeks of gestation,they start swallowing amniotic fluid, and by 18-20 weeks, early sucking movements are noticeable.These skills continue to develop and become more coordinated,allowing full term newborns to suck effectively[11,12].

Mature sucking consists of two parts: Suction and expression [13,14].

Suction is created by generating negative intraoral pressure through soft palate closure, lip tightening around the nipple, and lowering of the jaw[15].This prevents air entry while increasing oral cavity volume, allowing milk to be drawn .Expression happens when the tongue presses the nipple against the hard palate, squeezing out milk into the mouth [16].

Nutritive sucking (NS) facilitates milk movement through the oral cavity, with the epiglottis playing a crucial role in safeguarding the airway and guiding milk into the esophagus toward the stomach. Whereas Non-nutritive sucking(NNS) mainly provides comfort, enabling uninterrupted breathing without the actual transfer of milk[17] (Figure 3).This distinction between NS and NNS highlights the synchronized actions of swallowing and breathing during feeding.

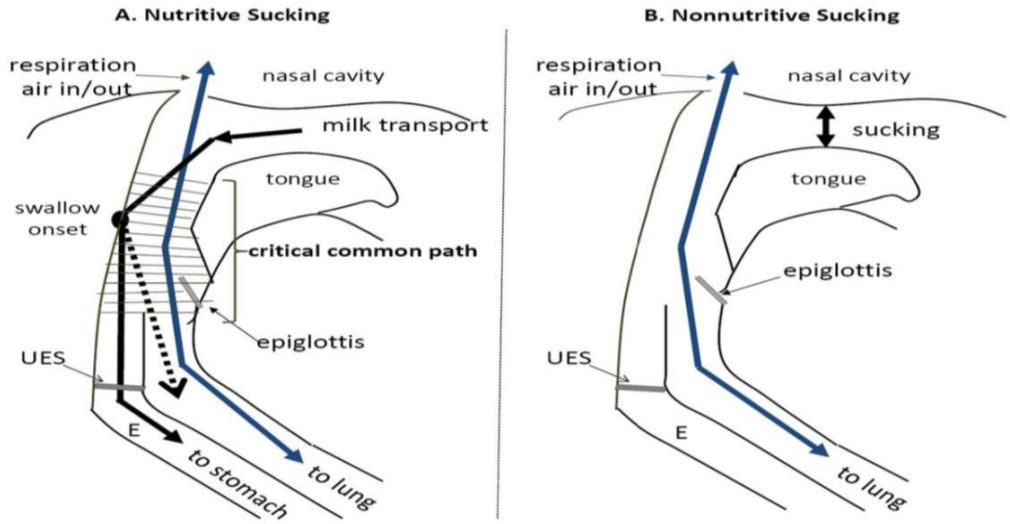

Figure 3: Development of suck and swallow mechanisms in infants.[17]

- **Non Nutritive Sucking Development**

Non Nutritive Sucking occurs when an infant sucks without feeding. In preterm infants, NNS typically appears several weeks before Nutritive Sucking (NS) and is considered an early indicator of feeding readiness. As infants mature, NNS becomes more rhythmic and stronger with 34 weeks gestational age[18-21].

- **Nutritive Sucking Development**

Nutritive Sucking involves actively drawing milk from the breast or bottle and requires a coordinated suck-swallow-breathe pattern. Compared to NNS, nutritive sucking demands greater tongue movement and follows a slower, rhythmic pattern with necessary pauses for swallowing and breathing.[22] Both maturation and practice contribute to improved NS skills[23-26].The development of NNS and NS progresses through five primary stages(Table-2). Knowing these stages will help in providing individualized feeding plans based on the infant's developmental stage[27].

Clinical identification of sucking stages in infants, especially preterm, relies on observing oral motor behaviors and coordination.

I. In Stage 1 (Immature Sucking), there is no suction, and only arrhythmic tongue compression is noted during oral attempts, indicating early oral skill development [28,29]. Non-nutritive sucking (NNS) using a pacifier is beneficial at this stage to stimulate oral reflexes and promote development [30].

II. In Stage 2 (Emerging Rhythmicity in Expression), rhythmic tongue movements are observed with fluid intake, but suction and jaw activity remain absent [28,31]. Oral motor stimulation, including lip, cheek, and gum massage, strengthens muscles and improves coordination [32,33].

III. In Stage 3 (Suction Appears, Arrhythmic), intermittent suction with partial lip seal and jaw movement is evident, though coordination remains inconsistent [28,29], here, paced feeding techniques, where caregivers control flow and allow pauses, enhance suction practice and feeding rhythm [34].

IV. In Stage 4 (Rhythmic Suction and Expression, Uncoordinated), suction and expression become rhythmic but not alternating, with possible pauses or mild desaturation [28]; cue-based feeding and proper positioning help improve coordination and reduce feeding stress [35].

V. In Stage 5 (Mature Sucking), there is rhythmic, alternating suction and expression, efficient suck-swallow-breathe coordination, and stable oxygenation [28,29]. Skin-to-skin contact (kangaroo care) supports physiological stability and enhances mature feeding patterns [36].

Table 2: The five primary stages of Non-Nutritive sucking (NNS) and Nutritive Sucking(NS)[21,37.]

Stage 1a The sucking pattern consists primarily of arrhythmic expression without suction
Stage 1b Sucking with attempts to generate suction and expression.
Stage 2a Although suction may be still absent, the expression component becomes rhythmic
Stage 2b The alternation of suction / expression begins to appear. Rhythmicity not yet established.
Stage 3a Sucking still consists of rhythmic expression without suction
Stage 3b The appearance of more rhythmic alternation of suction / expression with longer sucking bursts and stronger suction amplitude
Stage 4 Only rhythmic alternation of suction and expression is observed.
Stage 5 Greater suction amplitude and longer duration of sucking bursts than seen in Stage 4

Adapted in 2005 by Rogers and Arvedson from Lau et al., 2000 [21,37.]

- **Development of Suck-swallow-breath coordination in preterm infants**

Effective feeding relies on proper suck-swallow-breath coordination and the pharynx is involved in both swallowing and breathing. This coordination is especially important during nutritive sucking compared to nonnutritive sucking. Preterm infants often exhibit immature patterns and may swallow at different respiratory phases than full-term infants. Regulating milk flow by gavage feeding and adjusting milk volume and flow can aid in improving coordination.[38] Infants with respiratory conditions are at a higher risk of feeding challenges due to underdeveloped cardiorespiratory control which often manifests as apnea, bradycardia, oxygen desaturation, tachypnea, and increased work of breathing during feeding[11].

Feeding problems in the neonatal period

Feeding difficulties in preterm infants encompass a wide range of disorders, including oral feeding impairments, sucking-swallowing-breathing incoordination, and neurological or respiratory dysfunctions, primarily arising from developmental immaturity[8, 39](Figure 4).

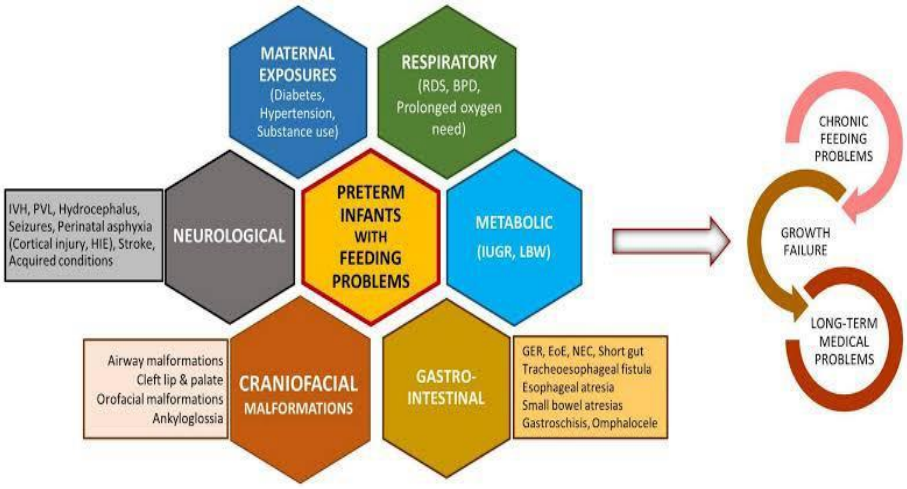

Figure 4: Risk factors & common clinical conditions associated with feeding problems in preterm babies[8].

Neonates face various feeding challenges due to immature development and medical conditions. Some of the common feeding problems include:

- **Immature Sucking and Swallowing Coordination**: Preterm infants often lack the mature coordination between sucking, swallowing, and breathing, which is essential for effective and safe feeding[12].

- **Dysphagia**: Swallowing difficulties can occur due to functional immaturity or neurological injuries. This can lead to aspiration or choking during feeding[40].

- **Oral Phase Disruptions**: The oral phase may be impacted by prolonged use of medical devices (e.g., endotracheal tubes) or by immature oral reflexes. This can cause weak sucking and poor bolus formation.[38,40]

- **Gastroesophageal Reflux** (GER): Immaturity of the esophageal sphincter often leads to reflux, causing discomfort, feeding aversion, and aspiration.[11,40]

- **Respiratory Problems**: Conditions like bronchopulmonary dysplasia can affect respiratory efficiency, further complicating feeding[8].

- **Neurological Injuries**: Preterm infants with conditions like intraventricular hemorrhage (IVH) or hypoxic-ischemic encephalopathy (HIE) may face oral-motor and swallowing impairments[8].

- **Sensory and Motor Disruptions**: Painful or noxious stimuli during the neonatal intensive care unit (NICU) stay can lead to oral aversion and altered oral motor skills[41].

- **Prolonged Feeding Tube Use**: Long-term use of nasogastric or orogastric tubes can delay the development of normal oral feeding skills.

Associated Comorbidities: Other medical complications, such as necrotizing enterocolitis or congenital heart disease, can delay feeding milestones and exacerbate feeding difficulties.

Interventions to Overcome Feeding Difficulties

Implementing targeted interventions can significantly improve feeding outcomes in neonates experiencing feeding difficulties[42].

A) Supportive Feeding Strategies

- **Nasogastric Tube Feeding**

This method can be used to supplement or fully feed infants who are unable to breastfeed effectively. Tube feeding is used for preterm infants until they can develop sufficient oral feeding skills[43].

- **Gradual Introduction to Oral Feeding**

For some infants, it may be necessary to introduce oral feeding slowly. This might begin with small volumes of breast milk or formula and gradually transition to breastfeeding as the infant gains more coordination and strength.

- **Timed and Frequent Feedings**

Preterm infants often need to be fed more frequently due to their smaller stomachs and slower digestion. Timed feedings and frequent checks on the infant's weight and growth are crucial to ensure they are receiving adequate nutrition[43].

- **Support for Parents**

Providing emotional and psychological support for parents is critical. Counseling services or parent support groups can help alleviate anxiety, bolster confidence in feeding practices, and strengthen the mother-infant bond[44].

In some cases, engaging parents in infant care (such as through kangaroo care or skin-to-skin contact) can improve feeding success and also promote bonding.

- **Reflux Management**

Since late preterm infants are more prone to gastroesophageal reflux (GER), feeding management strategies such as positioning the infant upright after feedings, using thicker formula, or medication (if necessary) may be implemented to help mitigate reflux symptoms and improve feeding tolerance.

B) Approaches to enhance feeding practices

Oral feeding is a major developmental step that requires the coordination of muscles, mouth movements, digestion and sensory responses.[37,45]

- **Clinical assessment of feeding problems**

To ensure effective management, feeding difficulties in infants should be regularly monitored, addressed with appropriate interventions, and reassessed as they develop. Early detection and treatment are crucial in minimizing potential long-term complications and supporting healthy growth and development (Figure 5)[8].

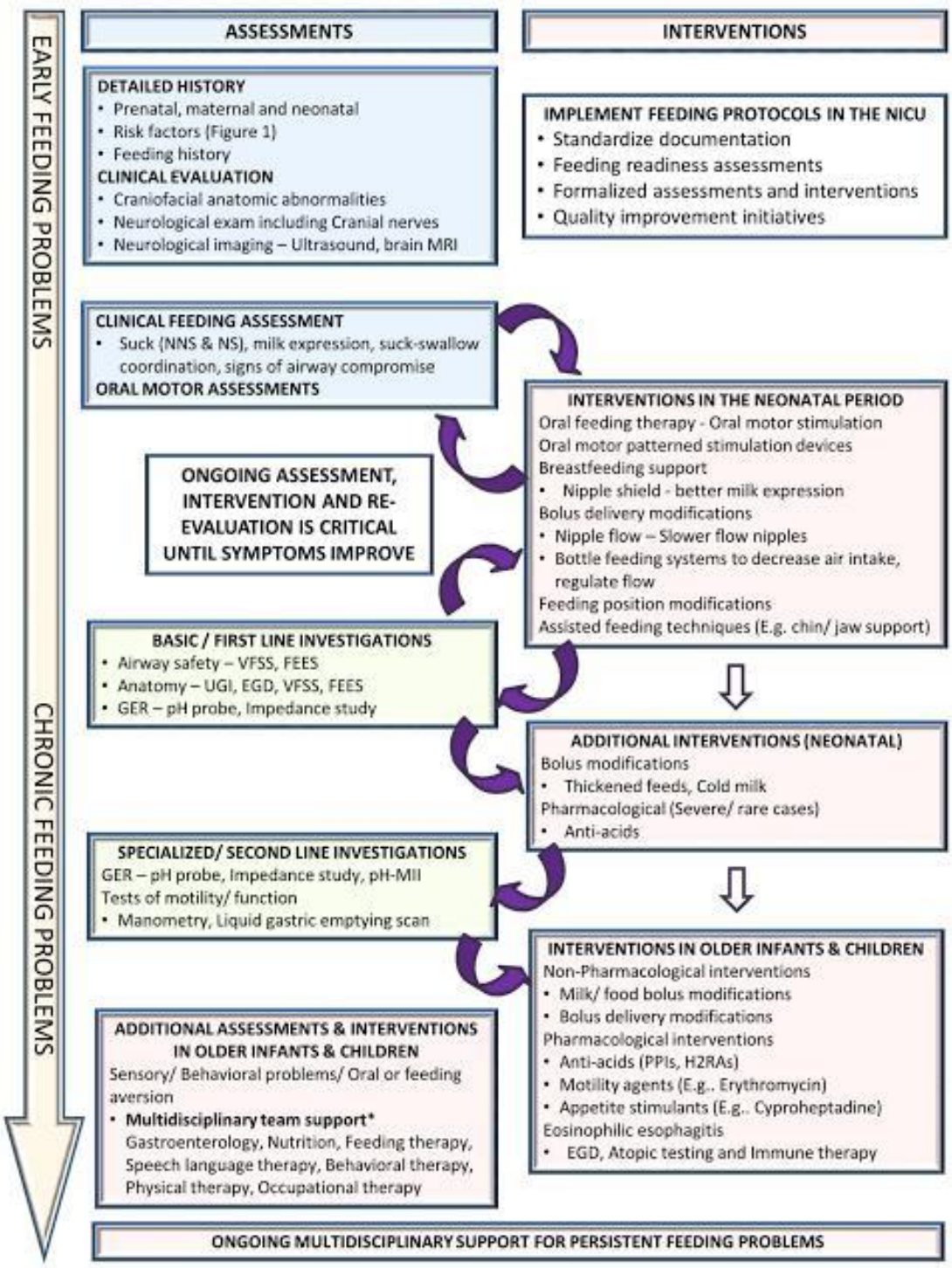

Figure 5: Approach to a preterm infant with feeding problems. (EGD: esophagogastroduodenoscopy, FEES:fiberoptic endoscopic evaluation of swallowing, GER: gastroesophageal reflux, H2RA: H2-receptor antagonists,MRI: magnetic resonance imaging, NICU: neonatal intensive care unit, NNS: non-nutritive suck, NS: nutritive suck, pH-MII: pH monitoring multichannel impedance, PPIs: proton pump inhibitors, UGI: upper gastrointestinal fluoroscopy, VFSS: videofluoroscopic swallow study**)[8].**

- **Intervention strategies for feeding issues**

Numerous interventions as below are available to improve the nutritional and physiological status of preterm babies by reducing feeding intolerance.

1. **Non nutritive sucking**
2. **Oromotor stimulation**
3. **Abdominal massage therapy**
4. **Tactile stimulation**
5. **Vestibular stimulation**
6. **Olfactory stimulation**

1. Non nutritive sucking

Non-nutritive sucking (NNS) happens when an infant sucks without receiving any milk or nutrients. This natural reflex helps to satisfy the baby's instinct to suck and can also support self-soothing. Pacifiers are commonly used for this purpose, acting as an alternative to thumb-sucking, a behavior that can begin as early as 12 weeks of gestation. Other ways to encourage non-nutritive sucking include using a caregiver's clean, gloved finger or allowing the baby to suck on an empty breast.[46]

This practice is beneficial because it helps infants develop their sucking skills and supports digestion. When a baby engages in non-nutritive sucking, it may trigger the release of certain digestive enzymes and hormones, such as lingual lipase, gastrin, insulin, and motilin. These hormones play a role in improving the digestion of milk and are thought to be activated through vagal nerve stimulation during sucking.[46]

2. Oromotor stimulation

The Premature Infant Oral Motor Intervention (PIOMI) is an oral stimulation protocol designed to enhance feeding skills in preterm infants. It involves a five-minute session administered three times daily, scheduled 20 minutes prior to feeding, over a period of seven consecutive days. The technique comprises specific steps including lip roll, lip curl or stretch, gum massage, and cheek stroking, concluded with suck elicitation[47].

A randomised controlled trial by Arora, et al., included 30 preterm infants (16 in intervention and 14 in the control group) to determine the effect of oromotor stimulation on time to achieve full spoon feeds. Study showed that neonates in the intervention group began full oral feeding earlier than those in the control group (P = 0.001). Study results also showed significant weight gain in the intervention group compared to the control group (P = 0.001)[48].

A systematic review by Calk (2019), the use of intra-and peri-oral stimulation in preterm infants significantly improved feeding efficiency ($p < 0.0001$), increased weight gain ($p < 0.05$), and shortened hospital stay ($p = 0.0001$), highlighting its effectiveness in enhancing feeding outcomes and overall recovery[49].

3.Abdominal massage therapy

Research indicates that abdominal massage is a safe, non-invasive nursing intervention with therapeutic benefits for preterm neonates. A study by Abd Elrazek et al. (2022) demonstrated that technique significantly improved feeding tolerance indicators, including increased frequency of stool, reduced vomiting, decreased abdominal distention, and lowered gastric residual volume ($p < 0.001$).The massage

was performed using gentle,clockwise circular motions over the abdomen for 10 minutes,twice daily, effectively stimulating bowel motility and aiding digestion. Additionally, infants receiving abdominal massage experienced significant weight gain over a five-day period, with mean weights increase. ($p < 0.001$)[50].

4.Tactile stimulation

Tactile stimulation during feeding has been shown to improve feeding efficiency in preterm infants by reducing the time needed to achieve full oral feeding[51]. Gentle touch, such as stroking the infant's cheeks, lips, and limbs or providing light pressure on the body can be used during gavage or oral feeding, helps to align feeding experiences with the infant's neurological expectations, supporting digestion, weight gain, and neurodevelopment[51]. Pickler et al.(2020) found that preterm infants receiving tactile stimulation achieved full oral feeding approximately 5 days earlier than those who did not($p<0.05$)[51]. This structured sensory input strengthens neuronal connections and improves feeding skills. Additionally, parental involvement in touch-based care, including skin-to-skin contact and gentle massage, further enhances bonding, reduces stress, and promotes overall well-being[51]. Integrating tactile stimulation into NICU care is a simple yet effective intervention to support feeding and developmental outcomes in preterm infants[51].

5.Vestibular stimulation

Vestibular stimulation methods used in preterm infants to promote weight gain include gentle rocking, slow swinging, and controlled positional changes. Kangaroo care, where the baby is held skin-to-skin against the caregiver's chest, provides natural movement that stimulates the vestibular system while supporting feeding and bonding. Slow horizontal or vertical movements, such as gently lifting and lowering

the infant while securely held, can enhance muscle tone and digestion. Therapeutic handling by trained physiotherapists, including rhythmic head movements and guided repositioning, helps to improve motor coordination and feeding skills. Some NICUs also use specially designed nests or hammocks that allow gentle motion, mimicking the natural movements experienced in the womb. Vidhyasagar et al.(2022),preterm infants receiving vestibular stimulation gained significantly more weight,averaging 18-25 grams more per day over one week ,compred to controls($p<0.01$). Regular application of these techniques has been shown to support better weight gain and overall development in preterm infants[52].

6.Olfactory stimulation

Olfactory stimulation is a non-pharmacological approach used to address feeding difficulties in newborns. This technique helps babies to develop their sucking skills and coordinate sucking, swallowing and breathing making it easier for them to start feeding sooner.

- **What is olfactory stimulation?**

An olfactory stimulus refers to any scent that activates the olfactory system, enabling the sense of smell[53].

- **History of olfactory stimulation:**

Olfactory genes,which form the largest gene family in humans,play a key role in memory, taste and processing sensory information.[54,55]

Fetal olfactory receptors begin to develop by the 8th week of pregnancy, with more mature ciliated receptors forming by the 24th week.By the 28th week, the nasal lining can produce proteins linked to the sense of smell[56-58].Both premature and full

term infants are born with a well developed olfactory system,allowing them to detect,process,remember,and recognize different scents,including human milk,even if they haven't been exposed to it after birth[59,60].

Research shows that between 28 and 35 weeks of postmenstrual age(PMA),a baby's sense of smell develops quickly.Exposure to the scent of human milk can enhance a preterm infants feeding responses,such as sucking and rooting. Additionally, the unique smell of a mother's milk helps premature babies recognize and prefer their own mothers milk over others,and even over formula.[61]

For over 120 years, the role of smell and taste in food enjoyment and digestion has been widely recognized. Henry Finck emphasized the significance of smell in dining experiences, stating that the majority of our enjoyment of food comes from our sense of smell rather than taste.

Pavlov's experiments with dogs further demonstrated this connection. He found that when food was placed in a dog's mouth, it triggered significant gastric secretions, even if the food never reached the stomach. In contrast, when food was inserted directly into the stomach without the dog's awareness, digestive secretions were minimal, and the food remained undigested for over an hour. This anticipatory activation of digestive pathways is now known as the cephalic phase response.[62]

The cephalic phase response prepares the digestive system for food intake by increasing gut motility and stimulating the release of various enzymes and hormones, including ghrelin, insulin, leptin, and gastrin(Figure 6).These substances help to regulate blood sugar levels and improve digestion. In preterm infants, challenges related to gut motility, digestion, and metabolic regulation are critical concerns in their nutritional management.[63]

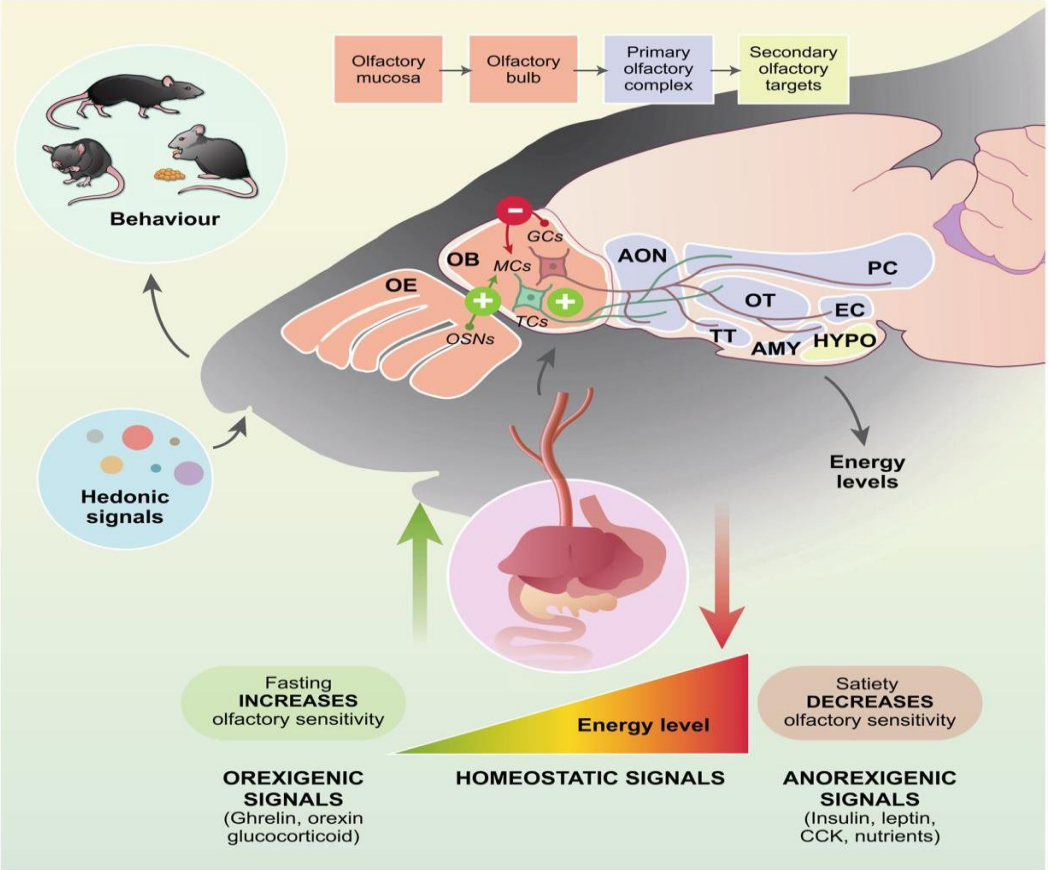

Figure 6: Representation of the olfactory bulb as an environmental sensor and integral component of the neuroendocrine system. (A simplified ventrolateral schematic of the brain is shown. Hedonic odour signals are detected by specialized cells (olfactory sensory neurons, OSNs) in the olfactory epithelium (OE) that project to the olfactory bulb (OB) where mitral cells (MCs) and tufted cells (TCs) are activated. MCs/TCs are excitatory glutamanergic cells and are the main projecting neurons of the OB, conveying odour information to various regions in the olfactory cortex for odour recognition and processing, or further modulating secondary olfactory structures, such as the hypothalamus (HYPO). MCs project their axons dispersedly to the olfactory cortex, including the anterior olfactory nucleus (AON), piriform cortex (PC), amygdala (AMY), entorhinal cortex (EC), olfactory tubercle (OT) and tenia tecta (TT), while TCs only innervate the anterior parts of the AON, OT and PC. MCs/TCs also make connections with inhibitory GABAnergic granule cells (GCs). Besides sensing odours, the OB is a metabolic sensor, sensing homeostatic signals (hormones, nutrients) from the periphery delivered by the stomach, intestine, pancreas, liver, and adipose. Thus, the OB integrates internal and external signals and guides behaviors and physiological responses (cognition, digestion, metabolism) by modulating olfaction performance and other brain areas**)**[64]**.

- **Impact of olfactory stimulation**

Early exposure to breast milk odor can enhance feeding abilities by stimulating essential digestive processes such as increased saliva production, improved food movement through the digestive tract, and the release of digestive enzymes and hormones[65].

It also helps preterm babies with delayed feeding by improving their ability to coordinate sucking, swallowing, and breathing[66].

In the NICU, exposure to strong chemical odors from disinfectants and skin-cleaning products can increase stress in newborns, while familiar scents like breast milk, maternal body odor, and amniotic fluid can promote physiological stability by reducing stress, regulating heart rate, breathing, and oxygen levels, and supporting adaptive behavior[67,68].

Studies have also shown that the smell of breast milk encourages preterm neonates to actively search for the nipple and display stronger rooting reflexes, which supports better feeding[69].

Furthermore, breast milk odor not only improves feeding but also enhances sleep quality, as newborns who consume more due to their preference for the scent experience greater satiety, leading to faster sleep onset and improved sleep duration[70].

Overall, maternal breast milk odor has significant benefits for preterm neonates by reducing stress, improving feeding, and enhancing sleep, all of which contribute to healthier growth and development.

- **Olfactory stimulation in neonates**

Research suggests that olfactory stimulation can help:

In preterm infants born before 29 weeks gestation where olfactory stimulation with maternal breast milk has been shown to shorten the time to achieve full oral feeds [71].

- Newborns with difficulties in coordinating breathing, sucking, and swallowing, olfactory stimulation can positively influence the transition from gavage to oral feeding in infants[72].
- Infants with brain injuries from birth complications[73].
- Infants unable to feed orally due to medical conditions such as congenital heart disease or severe birth defects[74].

- **Prerequisites for olfactory stimulation**

There are various methods to provide olfactory stimulation for newborns, with no single universally accepted technique. Different approaches are based on varying schools of thought[75].

- Parental education: Parents should receive detailed information regarding the purpose, benefits, and possible side effects of olfactory therapy[75].
- Continuous monitoring: Continuous monitoring of vital signs is necessary throughout the session to detect any apneic episodes[76].
- Infection control and infant comfort: To minimize the risk of infections, gloves should be worn during the intervention. If the infant shows signs of

discomfort or does not tolerate the therapy, it should be stopped immediately[75].

- **Procedure for providing olfactory stimulation**

Based on the information from different studies the following procedure can be followed for olfactory stimulation using breast milk[4,77,78-81].

1. Preparation of Breast Milk Odor Source

- Freshly expressed breast milk or previously collected and refrigerated breast milk is used.
- If refrigerated, the breast milk is warmed to body temperature (approximately 37°C) using a breast milk heater or a warm water bath to preserve its natural odor.

2. Application of the Odor Stimulus

- A sterile gauze pad or cotton pad is soaked with 5 ml of breast milk.
- The soaked pad is placed 2–5 cm away from the infant's nostrils.
- In some studies, the breast milk is placed in a storage box, and the lid is slightly opened near the infant's nose to release the odor.

3. Timing and Frequency of Stimulation

- Olfactory stimulation is administered before tube feeding, typically 5 minutes prior.
- The procedure is repeated three times a day until the infant transitions to full oral feeding.
- The exposure time varies, with some studies using 2 minutes of exposure per session, while others maintain exposure for up to 3 hours per day.

4. Monitoring and Evaluation

- The transition to full oral feeding is observed by tracking the infant's ability to coordinate sucking, swallowing, and breathing.

➢ **<u>Effect of olfactory stimulation among preterm infants</u>**

Previous research has shown that olfactory stimulation in preterm neonates leads to earlier initiation of oral feeding, improved sucking frequency, and better overall feeding performance, including higher intake and milk transfer rates. It also helps them transition to independent oral feeding more quickly, supports faster daily weight gain, facilitates an earlier shift from spoon feeding to breastfeeding, and reduces the length of hospital stay[4].

- **Effect on transition time**

A randomized controlled trial by Yildiz et al. conducted in Turkey included 80 preterm infants (gestational age 28–34 weeks, birth weight approximately 1000 g). In the intervention group, a sterile pad soaked in the mother's breast milk was positioned 2 cm from the infant's nose at the start of each feeding session and removed once feeding ended, while the control group received standard tube feeding without olfactory stimulation. The study found that infants exposed to breast milk odor achieved full oral feeding significantly faster than those in the control group ($P < 0.05$). However, there were no statistically significant differences in hospital stay duration ($P = 0.55$) or weight gain at discharge ($P > 0.05$). The authors concluded that breast milk odor can support earlier oral feeding but does not influence hospital stay or weight gain[4].

In another randomized controlled trial, Lee EJ evaluated the effect of breast milk olfactory stimulation on feeding progress, physiological stability, and weight gain in 28 preterm infants (gestational age 28–32 weeks, appropriate for gestational age). The intervention involved placing sterile gauze soaked with 5 mL of warmed (60°C) breast milk 2 cm from the infant's nostrils during feeding, twice daily, three times per week, over 15 days. The control group received standard care without olfactory exposure. The results indicated that the intervention group transitioned to full oral feeding more quickly than the control group ($P < 0.05$). However, no significant differences were noted in weekly weight gain ($P > 0.05$) or hospital stay length ($P > 0.05$). The study concluded that breast milk odor supports oral feeding progression but does not affect weight gain or hospitalization duration[78].

Similarly, Küçük Alemdar D and Inal S conducted a randomized controlled study involving preterm infants (gestational age 30–34 weeks, birth weight ≥1000 g) to assess the impact of breast milk odor on feeding outcomes. In the intervention group, 5 mL of breast milk was applied to a sterile sponge placed 5 cm from the infant's nose for three hours daily, while the control group received routine care. Infants in the intervention group achieved full oral feeding significantly earlier ($P < 0.05$), but no significant differences were found in hospital stay ($P > 0.05$) or weekly weight gain ($P > 0.05$). The researchers concluded that breast milk odor aids in the transition to oral feeding without influencing other clinical outcomes[77].

The prospective cohort study by Davidson J, Ruthazer R, and Maron JL investigated the effects of early olfactory stimulation with maternal breast milk on oral feeding skills in preterm infants receiving tube feeding. The intervention group was exposed to maternal breast milk odor before each tube feeding, while the control group received standard care without olfactory stimulation.Findings revealed that

infants exposed to early olfactory stimulation transitioned to full oral feeding more quickly than those in the control group (P = 0.02), indicating a positive impact on feeding progression. However, length of hospital stay was not significantly reduced (P = 0.48) and weekly weight gain showed no significant difference (P = 0.31). The study concluded that while early exposure to breast milk odor may enhance oral feeding skills, it does not significantly affect hospital stay duration or weight gain.[64]

Beker F et al in 2021 investigated the effects of breast milk odour and taste stimulation on feeding progression in preterm infants (<29 weeks gestation and/or <1250 g birth weight). The intervention group was exposed to a gauze swab soaked in breast milk placed near the nostrils before each tube feeding, while the control group received standard care.Results showed a significantly faster transition to full oral feeding in the intervention group (P = 0.004), but no significant difference in hospital stay duration (P = 0.55) or weekly weight gain (P = 0.21). The study concluded that breast milk odor and taste stimulation can help preterm infants transition to oral feeding sooner but does not impact hospital stay or weight gain.[81]

In 2015, Iranmanesh et al investigated the effects of breast milk odor stimulation on feeding progression in preterm infants receiving gavage feeding. The intervention group was exposed to maternal breast milk odor before each feeding, while the control group received standard care. Results showed a significantly shorter transition to full oral feeding in the intervention group (P = 0.01). However, hospital stay duration was not significantly different between the groups, with the intervention group having a mean hospital stay of 25.4 ± 4.6 days and the control group 26.1 ± 5.2 days (P = 0.45). Weekly weight gain also showed no significant difference (P = 0.37). The study concluded that breast milk odor exposure supports earlier oral feeding but does not significantly impact hospital stay duration or weight gain.[82]

The systematic review and meta-analysis by Qin Y, Liu S, Yang Y, Zhong Y, Hao D, and Han H evaluated the impact of human milk odor stimulation on feeding progression in premature infants. The study included six randomized controlled trials with a total of 763 preterm infants, assessing the effects of breast milk odor on feeding outcomes. The intervention consist of exposing preterm infants to the odor of human milk before feeding, while control groups received routine care without olfactory stimulation. The meta-analysis found that infants who received breast milk odor stimulation had a significantly shorter transition time to full oral feeding compared to controls ($P < 0.00001$), indicating a strong positive effect on feeding development. Additionally, the duration of parenteral nutrition was significantly reduced in the intervention group (MD = -1.01 days, 95% CI [-1.70, -0.32], $P = 0.004$). However, the length of hospital stay did not show a significant difference between the groups (MD = -0.03 days, 95% CI [-0.41, 0.35], $P = 0.86$). The study concluded that human milk odor stimulation is an effective, non-invasive intervention to promote earlier oral feeding and reduce the need for parenteral nutrition in preterm infants, but its impact on hospital stay and weight gain remains inconclusive.[83]

- **Effect on weight gain**

The study by Ahmed FA examined the effects of breast milk odor stimulation on weight gain, first breastfeeding time, and hospital stay duration in preterm infants. This study included preterm infants who were receiving gavage feeding, with the intervention group exposed to maternal breast milk odor before each feeding, while the control group received standard care without olfactory stimulation. Results showed that the intervention group had a significantly shorter time to first breastfeeding compared to the control group ($P = 0.02$), suggesting that breast milk odor stimulation may promote earlier feeding initiation. Weekly weight gain was also

significantly higher in the intervention group (P = 0.03), indicating a potential benefit for growth. However, hospital stay duration was not significantly different between the groups, with the intervention group staying a mean of 24.8 ± 3.9 days compared to 26.2 ± 4.5 days in the control group (P = 0.27). The study concluded that breast milk odor stimulation can enhance feeding readiness and weight gain in preterm infants but does not significantly impact hospital stay.[84]

The study by Mohammadi et al. examined the effects of breast milk olfactory stimulation on behavioral responses and feeding progression in preterm neonates. The intervention group was exposed to maternal breast milk odor, while the control group received routine care. Results showed that infants in the intervention group had significantly better-organized behaviors, including more stable sleep-wake cycles, reduced agitation, and improved sucking reflexes, which are essential for feeding readiness. Weight gain was significantly higher (P < 0.001), and milk intake increased significantly on days 3 and 7 (P < 0.005, P < 0.001). The study concluded that breast milk odor positively influences feeding and behavioral development in preterm infants.[85]

- **Effect on duration of hospital stay**

The randomized controlled trial by Khodagholi et al. examined the effects of mother milk odor stimulation combined with non-nutritive sucking on feeding outcomes in 32 preterm infants (gestational age 28–32 weeks, birth weight ≥1000 g). In the intervention group, cotton pads soaked with the mother's breast milk were placed 2–3 cm from the infant's nose for 5 minutes before tube feeding, three times daily for 10 days, while the control group received standard care without odor exposure. The results demonstrated a significantly shorter duration for transition to full oral feeding in the intervention group (P < 0.05), indicating a beneficial effect on

feeding progression. However, length of hospital stay ($P > 0.05$) and weekly weight gain ($P > 0.05$) did not show significant differences between the groups. The study concluded that maternal milk odor stimulation, when combined with non-nutritive sucking, can enhance the transition to oral feeding in preterm infants but does not significantly influence weight gain or hospital stay duration.[77]

- **Additional Benefits of Breast Milk Odour**

Maternal breast milk odor has a calming and pain-relieving effect on preterm infants, as shown in a study by Badiee et al. The study involved 50 preterm infants (32–37 weeks gestation), where the intervention group was exposed to maternal breast milk odor, while the control group was exposed to formula milk odor during a heel lancing procedure.

Infants in the breast milk odor group had significantly lower pain scores (PIPP: 5.4 vs. 9, $P < 0.001$) and a smaller increase in salivary cortisol levels (17.7 nmol/L vs. 25.3 nmol/L, $P < 0.001$), indicating reduced stress and pain perception. The findings suggest that maternal breast milk odor is a simple, non-invasive method for pain relief in preterm infants, although its effects on hospital stay, oral feeding transition, and weight gain were not evaluated.[86]

Maternal breast milk odor has a pain-relieving effect on premature infants, as demonstrated by Ranjbar et al. The study included 48 preterm infants (28–37 weeks gestation), with the intervention group exposed to breast milk odor 30 seconds before a heel stick procedure, while the control group received routine care. Findings showed that infants in the intervention group had significantly lower pain scores ($z = -2.04$, $P = 0.021$), indicating that breast milk odor can help reduce pain perception. The study concluded that breast milk odor is a simple and effective non-pharmacological method for pain management in preterm infants.[87]

Zeraatian et al. investigated the impact of breast milk odor on infant pain and stress levels. The study found that exposure to maternal breast milk odor significantly reduced pain responses in neonates, with a standardized mean difference [(SMD) -1.60 (95% CI: -2.48, -0.72; $P < 0.05$)]. Additionally, improvements in physiological parameters such as oxygen saturation (MD: 1.64, 95% CI: 0.49, 2.80) and heart rate (MD: -6.73, 95% CI: -12.33, -1.13) were observed. However, the reduction in stress levels did not reach statistical significance (MD: -0.64, 95% CI: -1.87, 0.59). The study concluded that maternal breast milk odor could serve as a simple, non-invasive method for pain relief in neonates.[88]

MATERIALS AND METHODS

The study was conducted in the Department of Pediatrics, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi affiliated JN Medical College, Belagavi from April 2023 to March 2024.

Study design

A Randomized Clinical Trial

Study period

One year (April 2023 to March 2024)

Place

KLES Dr. Prabhakar Kore Charitable Hospital and Medical Research Centre, Belagavi, a teaching hospital affiliated to Jawaharlal Nehru Medical College, Belagavi.

Source of data

Preterm neonates (30-34 weeks) admitted to the NICU of KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

Sample size

The formula used for sample size calculation is,

$$n = \frac{2S^2(z_{1-\alpha} + z_{1-\beta})2}{d^2}$$

Where, $Z_{1-\alpha}$= Z − value for α level (1.96 at 5% α error or 95% confidence)

$Z_{1-\beta}$= Z-value for β level (0.842 at 20% β error or 80% power)

d = Margin of error = 0.74, S = Pooled SD = (S1 + S2)/2

Number needed (n) = 49 should be taken in each group

Total sample size is 49 x 2=**98 subjects.**

Ethical clearance

Prior to the commencement, study was approved by the Ethical and Research Committee, Jawaharlal Nehru Medical College, Belagavi.

Eligibility

Inclusion Criteria:

1) Inborn babies between 30-34 weeks of gestation.
2) Physiologically stable infants with minimal respiratory support (CPAP with Fio2 ≤ 40% and CPAP ≤ 5cm of 24 to 48hrs)
3) Willing to participate in the study

Exclusion Criteria:

1) Major congenital anomalies that affect feeding (craniofacial malformations, Tracheoesophageal fistula, congenital diaphragmatic hernia, Intestinal Obstruction, severe congenital heart disease).
2) Necrotizing enterocolitis, stage 2 and 3
3) Intra ventricular hemorrhage, grade 3 and 4
4) Perinatal asphyxia with HIE stage 2 and 3
5) Babies who don't receive complete intervention for 7days
6) Babies not receiving intervention continuously for more than 24hrs after the initiation

METHODOLOGY

Data collection procedure:

Infants meeting the eligibility criteria were enrolled in the study within 24-48 hours of admission to NICU, after obtaining written informed consent. Enrolled infants were allocated to two groups.

Infants born on even dates to Group A (Intervention group)

Those born on odd dates to Group B (Control group).

Both groups received care as per NICU Protocol. Data was recorded in a structured proforma which includes infant data (Gestational age, Birth weight, sex, Date of birth), maternal data (Age, gravida, parity, education) and study outcomes.

All the Infants in both groups were monitored from admission till discharge. Monitoring was carried out for capturing the study outcomes like time to achieve full oral spoon/paladai feeds, weekly weight gain and duration of hospital stay.

Full oral feeds is defined as infants receiving volume of 140-160ml/kg/day or lesser volume if the baby is gaining weight adequately.

Length of hospital stay is defined as duration from date of admission to date of discharge from hospital. Weight was recorded using digital weighing scale.

Study procedure:

Olfactory stimulation with breast milk was performed in the intervention group. Olfactory stimulation was provided using cotton pads impregnated with one ml of mother's breast milk. If mother's breast milk was not available, cotton pad placed

on the mother's breast for five minutes was used for intervention. The cotton pad was placed near the Infants nasal septum (1.5-2cm) for a period of five minutes. This was performed **three times a day (8 am, 2pm, 8pm)** for seven days by the trained person (Nurse, mother, investigator). Mothers and nurses were trained for administrating the intervention.Training to provide intervention was conducted in person by investigator and also by using videos.

Cotton pads were checked prior, to ensure that they don't have any odor that would cause any interference with olfactory stimulation.

The intervention was discontinued if the infants become vitally unstable i.e., had desaturation and apnea or bradycardia during the intervention and was restarted to complete remaining days of intervention, when the baby is stabilized within 24 hrs. Intervention delivered was recorded.

Statistical analysis

Analysis was carried out by mean and standard deviation for quantitative variables, frequency, and proportion for categorical variables. Data will also be represented using appropriate diagrams like bar diagram, pie diagram and box plots.

The association between explanatory variables and categorical outcomes was assessed by cross tabulation and comparison of percentages. Chi square test was used to test statistical significance.

The association between quantitative explanatory variables and categorical outcomes was assessed by independent sample t-test (2 groups) will be used to assess statistical significance.

P value < 0.05 is considered statistically significant. IBM SPSS version 22 was used for statistical analysis[64].

RESULTS

The study was conducted at KLES Dr.Prabhakar Kore Hospital and Medical Research Centre, Belagavi over one year.A total of 98 preterm neonates(30-34 weeks gestation) were enrolled and divided into two groups of 49 each for comparison.

Table 3: Maternal age among the study groups

Maternal Age (yrs)	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
18-25	28 (57.14%)	29 (59.18%)	57 (58.16%)	0.144
26-30	12 (24.49%)	17 (34.69%)	29 (29.59%)	
>30	9 (18.37%)	3 (6.12%)	12 (12.24%)	
Total	49	49	98 (100%)	

In our study,more than half of participants i.e 58.16% were in the 18-25 years age group, while 29.59% were in the 26-30 years age group, 12.24% were in >30 years age group. No statistically significant difference was observed in the distribution of maternal age across the study groups (p = 0.144).

Figure 7: Maternal age among the study groups

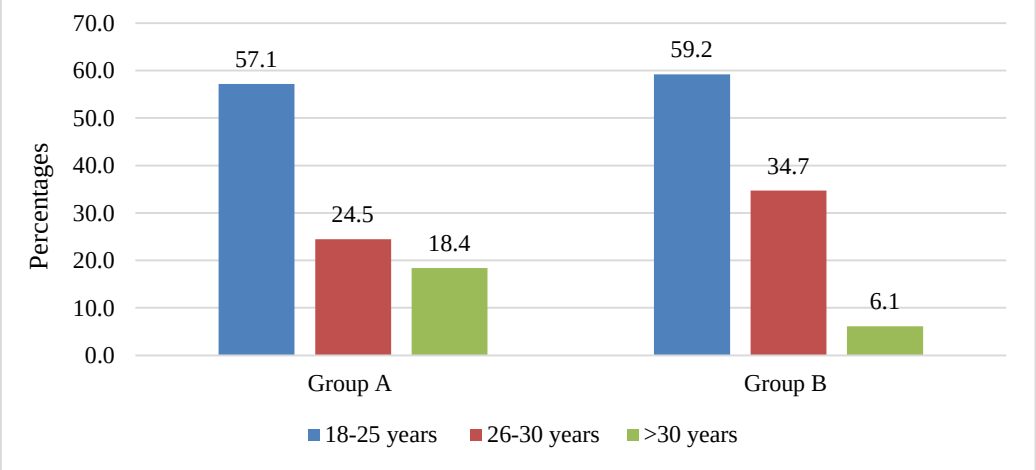

Table 4: Gender distribution amongst study participants

Gender	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
Male	29 (59.18%)	28 (57.14%)	57 (58.16%)	0.838
Female	20 (40.82%)	21 (42.86%)	41 (41.84%)	
Total	49	49	98 (100%)	

In current study, males accounted for 58.16% and females accounted for 41.84% of the participants. There was no statistically significant difference in gender distribution between Study groups (p = 0.838).

Figure 8: Gender distribution amongst study participants

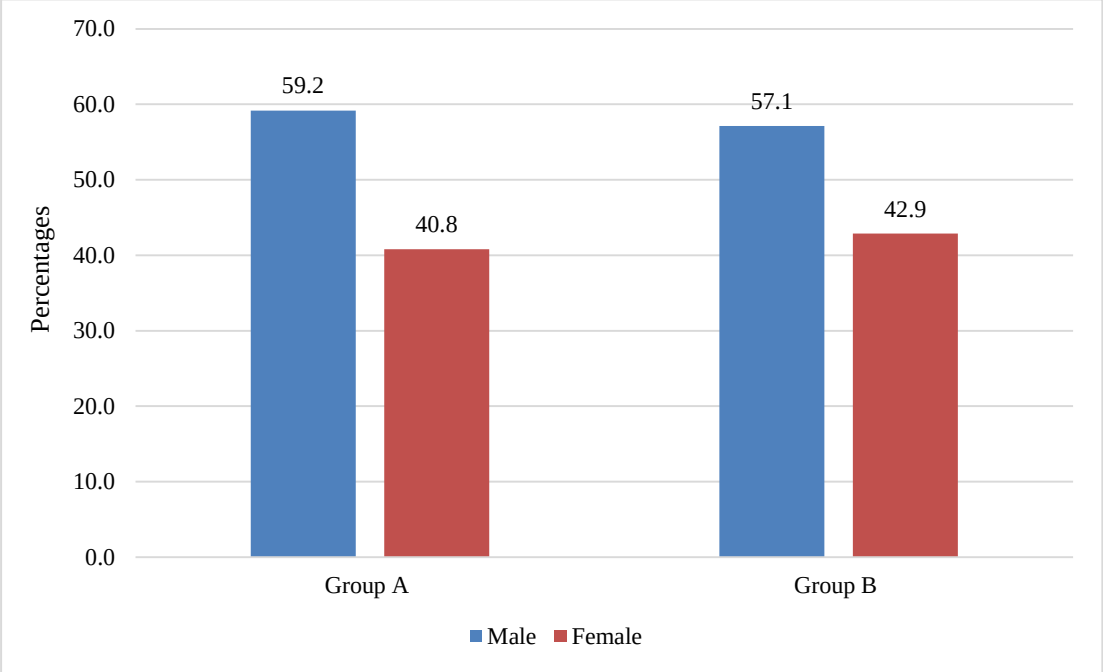

Table 5: Gestational age amongst study groups

Gestational Age (wks)	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
30-31^{+6}	15 (30.61%)	9 (18.37%)	24 (24.49%)	0.310
32-33 $^{+6}$	29 (59.18%)	32 (65.31%)	61 (62.24%)	
≥34	5 (10.2%)	8 (16.33%)	13 (13.27%)	
Total	49	49	98 (100%)	

In the present study, 62.24% of infants were between 32-33+6 weeks, 24.49% were born at 30-31+6 weeks, and 13.27% were born at ≥34 weeks. No statistically significant difference in the distribution of gestational age across the study groups (p = 0.310).

Figure 9: Gestational age amongst study groups

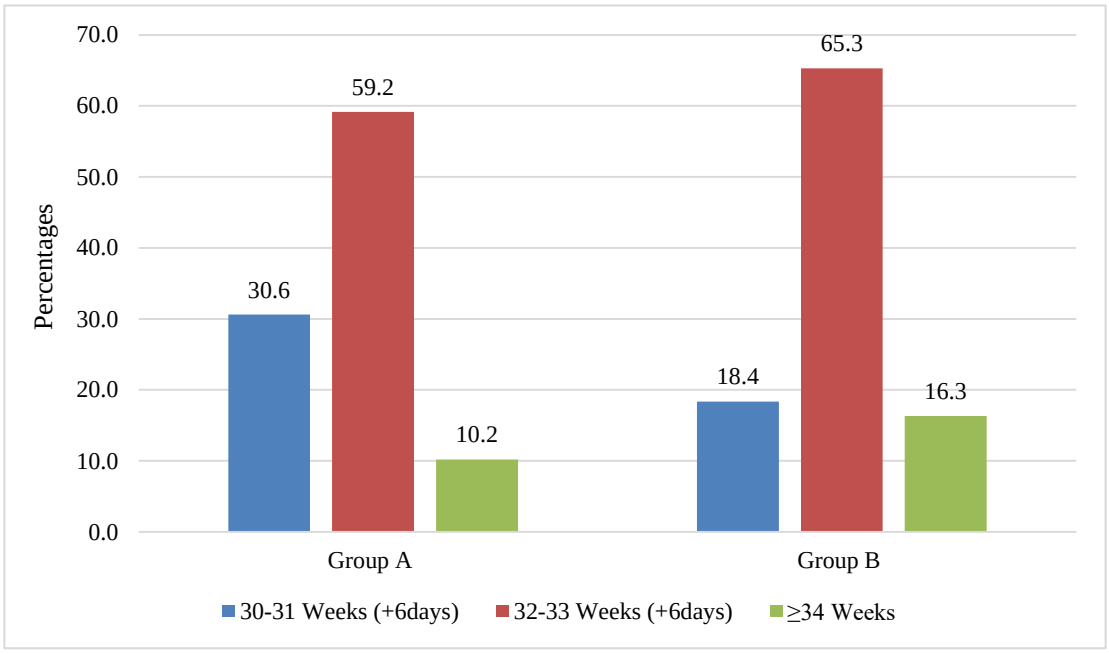

Table 6: Birth weight amongst study group

Birth Weight (grams)	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
≤1500	21 (42.86%)	21 (42.86%)	42 (42.86%)	0.896
1501-2000	25 (51.02%)	26 (53.06%)	51 (52.04%)	
>2000	3 (6.12%)	2 (4.08%)	5 (5.1%)	
Total	49	49	98 (100%)	

In this study, more than half of the infants i.e 52.04 percent, had a birth weight between 1501 and 2000 grams, making it the most common weight category. Less than half, 42.86 percent, of the infants weighed 1500 grams or less, indicating a significant proportion of low birth weight neonates. Meanwhile, only a small number, 5.1 percent, had a birth weight of more than 2000 grams.There was no statistically significant difference in birth weight distribution between the two study groups, with a p-value of 0.896

Figure 10: Birth weight amongst study groups

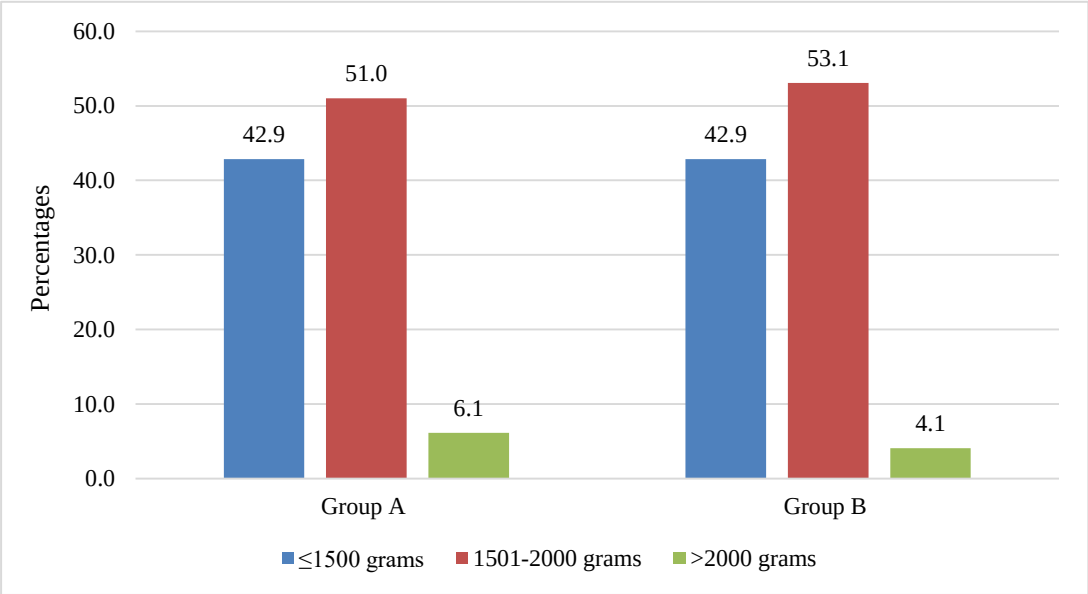

Table 7: Day of initiation of tube feeds amongst study groups

Initiation (days)	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
1-3	36 (73.47%)	44 (89.8%)	78 (81.25%)	0.111
4-6	11 (22.45%)	4 (8.16%)	15 (15.63%)	
7-9	2 (4.08%)	1 (2.04%)	3 (3.13%)	
Total	49	49	98 (100%)	

Our study showed that, 81.25% of infants had tube feeds initiated within 1 to 3 days, in 15.63% started within 4 to 6 days, and 3.13% began after 7 days. No statistically significant difference across the study groups (p = 0.111).

Figure 11: Day of initiation of tube feeds amongst study groups

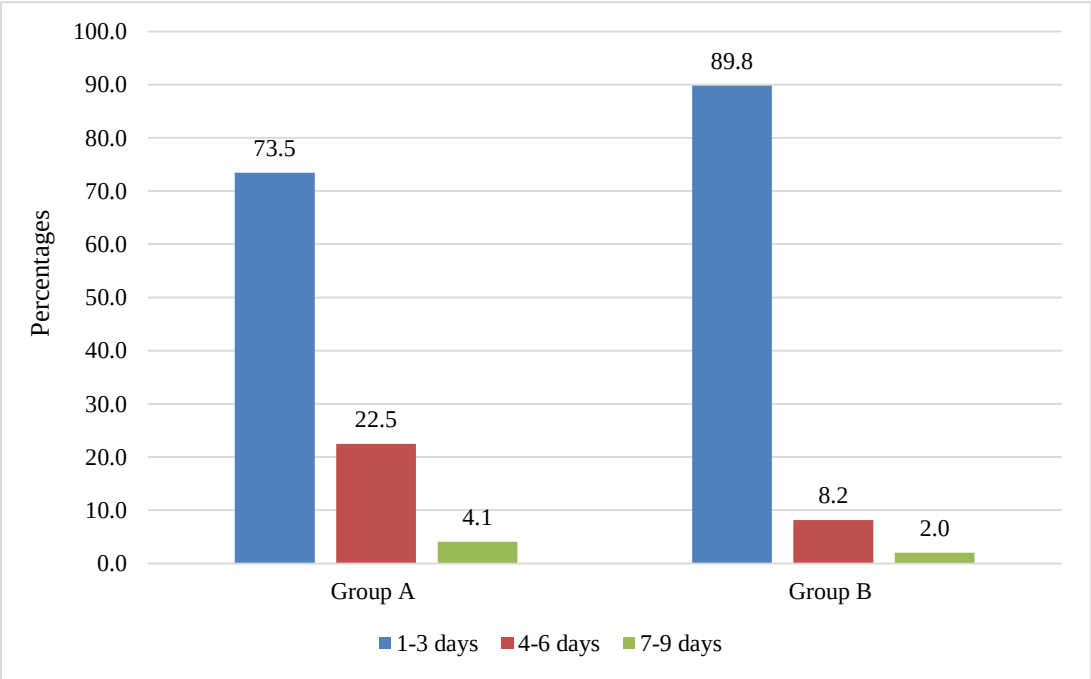

Table 8: Day of initiation of Spoon feeds among study groups

Initiation of Spoon Feeds	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
1-3	18 (36.73%)	25 (51.02%)	43 (43.88%)	0.210
4-6	14 (28.57%)	16 (32.65%)	30 (30.61%)	
7-9	11 (22.45%)	5 (10.2%)	16 (16.33%)	
>9	6 (12.24%)	3 (6.12%)	9 (9.18%)	
Total	49	49	98 (100%)	

In our study, 43.88% of infants started on spoon feeds within 1 to 3 days, followed by 30.61% within 4 to 6 days. There was no statistically significant difference in the study groups (p = 0.210).

Figure 12: Day Of Initiation of Spoon Feeds among study groups

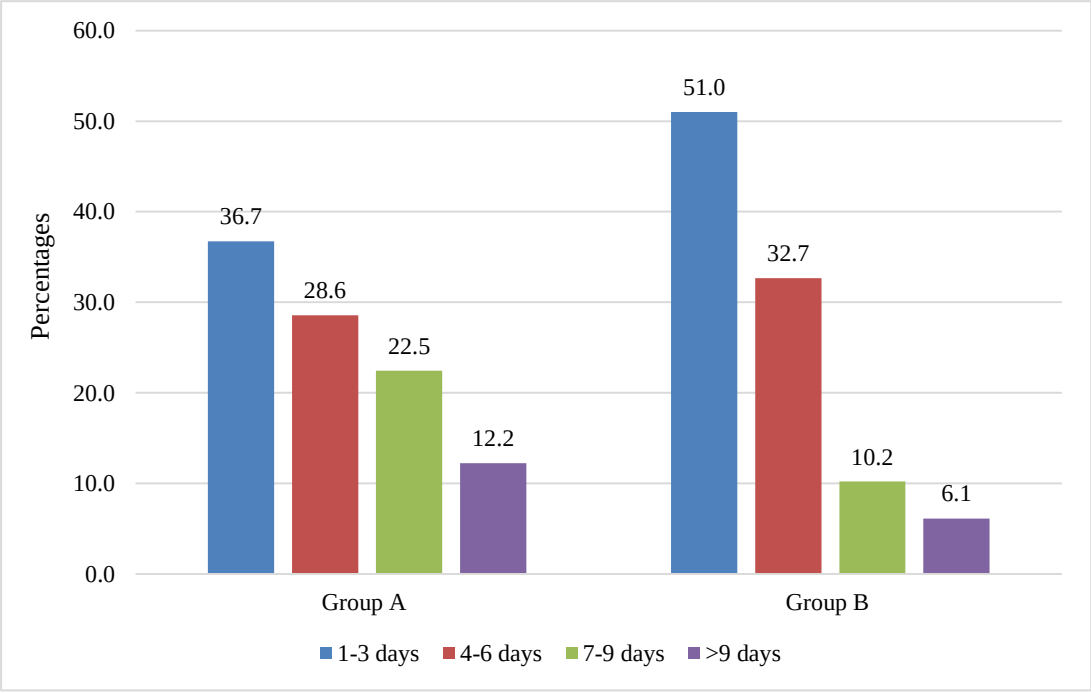

Table 9: Day of reaching full spoon feeds in the study participants

Achieving Full Spoon Feeds	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
1-3	9 (18.37%)	8 (16.33%)	17 (17.35%)	0.872
4-6	11 (22.45%)	12 (24.49%)	23 (23.47%)	
7-9	11 (22.45%)	15 (30.61%)	26 (26.53%)	
>9	18 (36.73%)	14 (28.57%)	32 (32.65%)	
Total	49	49	98 (100%)	

Based on our study, 32.65% of infants achieved full spoon feeds after 9 days, 26.53% within 7 to 9 days, 23.47% within 4 to 6 days, and 17.35% within 1 to 3 days. No statistically significant difference in the distribution of time to full spoon feeds across the study groups (p = 0.872).

Figure 13: Day of reaching Full Spoon Feeds in the study participants

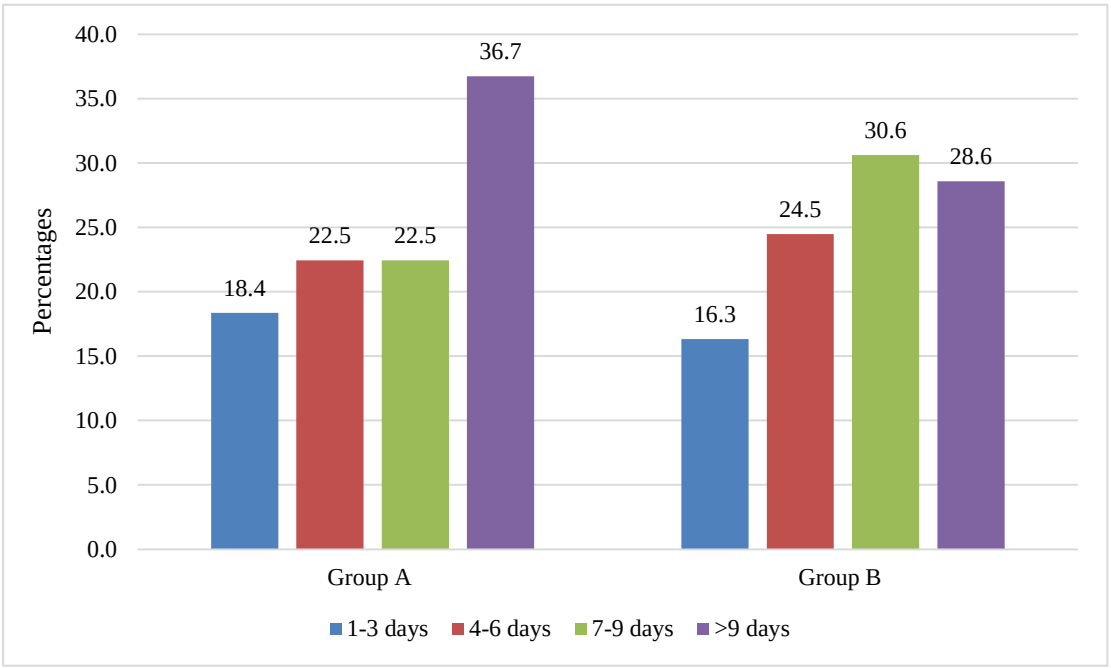

Table 10: Weekly Weight Gain among Study Groups

Weight (gms)	Group (Mean± SD)		Total (Mean± SD) (N)	p-value
	A (n=49)	B (n=49)		
At Enrolment	1556.73 ± 288.5	1534.29 ± 307.75	1545.51 ± 296.95	0.710
At 1st Week	-36.53 ± 33.68	-75.92 ± 18.33	-56.22 ± 33.46	<0.001
At 2nd Week	67.76 ± 56.84	46.41 ± 31.11	57.08 ± 46.82	0.023
At 3rd Week	24.98 ± 39.42	28.51 ± 34.89	26.74 ± 37.08	0.640
At 4th Week	6.33 ± 19.97	17.76 ± 36.64	12.04 ± 29.91	0.058
At 5th Week	0 ± 0	6.73 ± 23.66	3.37 ± 16.99	0.049
Total	49	49		

At enrolment, both groups had a comparable mean weight. During the first week, weight loss was significantly greater in Group B than in Group A ($p < 0.001$). By the second week, weight gain was significantly higher in Group A ($p = 0.023$). In the third ($p = 0.640$) and fourth weeks ($p = 0.058$), weight gain differences were not significant, while in the fifth week, the difference approached significance ($p = 0.049$).

Figure 14: Weekly weight gain among study groups

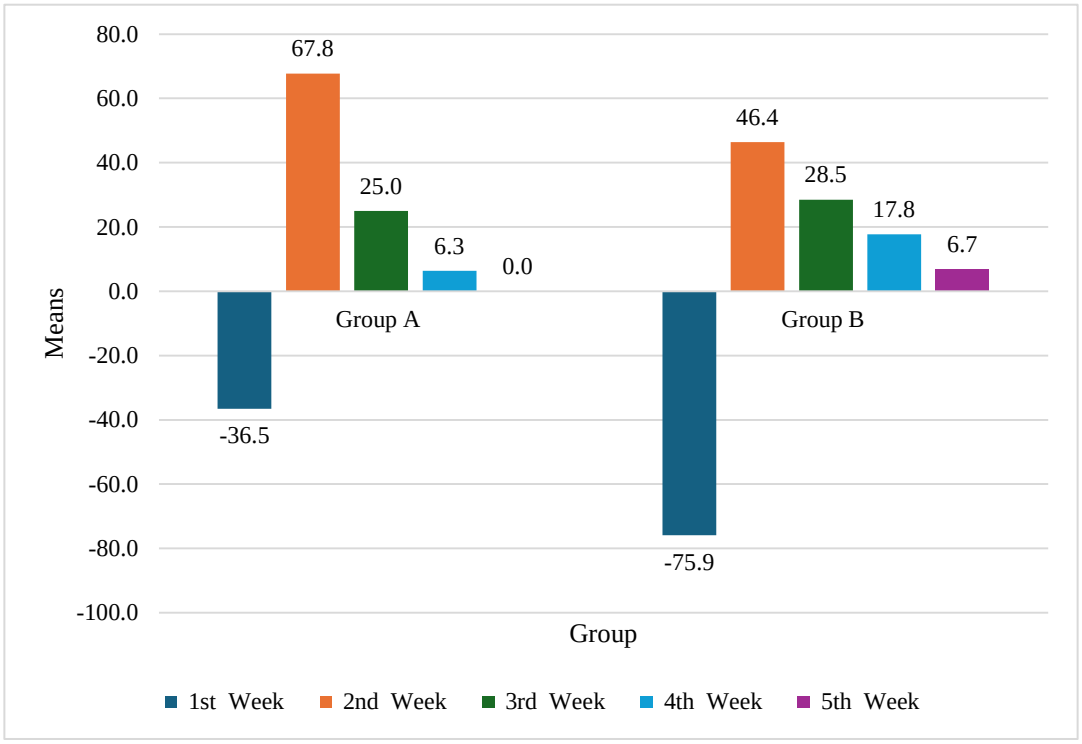

Table 11: Length of hospital stay among study participants

Hospital Stay (days)	Group		Total (N)	p-value
	A (n=49)	B (n=49)		
≤10	12 (24.49%)	5 (10.2%)	17 (17.35%)	0.003
11-20	30 (61.22%)	23 (46.94%)	53 (54.08%)	
21-30	7 (14.29%)	13 (26.53%)	20 (20.41%)	
31-40	0 (0%)	8 (16.33%)	8 (8.16%)	
Total	49	49	98 (100%)	

Hospital stay duration was significantly longer in Group B (p = 0.003). In Group A, a greater proportion of infants had shorter stays of ≤10 days, 24.49%, while extended stays of 21-40 days were more frequent in Group B. This suggests that infants in Group B had a longer hospitalization period compared to those in Group A.

Figure 15: Length of hospital stay among study groups

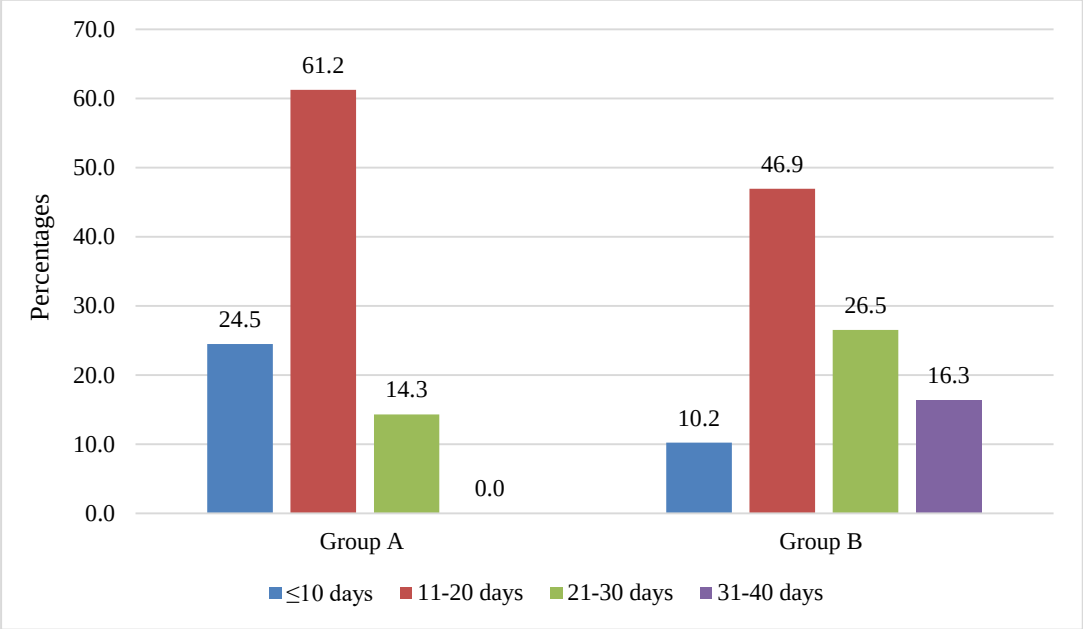

Table 12: Mean of outcome parameter across study groups

Parameter	Group (Mean± SD)		Total (Mean± SD) (N)	p-value
	A (n=49)	B (n=49)		
Day of Initiation of tube feeds	2.29 ± 1.65	2.18 ± 1.63	2.23 ± 1.63	0.758
Day of Initiation of spoon feeds (RT+SPOON)	4.55 ± 3.02	4.94 ± 3.89	4.74 ± 3.47	0.583
Day of Reaching Full spoon feeds	6.14 ± 3.52	10.39 ± 6.22	8.27 ± 5.46	<0.001
Duration of transition from gavage (RT & RT+SF) to full oral feeds(SF) in days	3.8 ± 2.52	8.27 ± 5.18	6.03 ± 4.63	<0.001
Length of hospital stay(days)	13.9 ± 5.28	19.88 ± 8.3	16.89 ± 7.54	<0.001

In our study ,Group A reached full spoon feeds earlier compared to Group B ($p < 0.001$), indicating a faster transition to independent feeding. The time of transition from gavage feeding to full oral feeds is also significantly shorter in Group A ($p < 0.001$), suggesting better feeding progression. Additionally, infants in Group A had a shorter hospital stay compared to Group B ($p < 0.001$).

Table 13: Mean of outcome parameter amongst Gestational age groups

Parameter	Gestational Age (wks)			Total (N)	p-value
	30-31 (+6Days) (n=24)	32-33 (+6 Days) (n=61)	≥34 (n=13)		
Day Of Reaching Full Spoon Feeds	10.58 ± 3.99	8.23 ± 5.85	4.15 ± 3.18	8.27 ± 5.46	0.002
Length Of Hospital Stay in Days	22.13 ± 8.99	16.03 ± 6.22	11.23 ± 4.27	16.89 ± 7.54	<0.001
Weight At Enrolment	1300.83 ± 254.8	1587.87 ± 254.51	1798.46 ± 257.52	1545.51 ± 296.95	<0.001
Weight At 1st Week	-52.29 ± 37.04	-61.07 ± 27.83	-40.77 ± 46.27	-56.22 ± 33.46	0.111
Weight At 2nd Week	47.5 ± 45.13	69.37 ± 44.46	41.67 ± 47.83	60.15 ± 46.1	0.048
Weight At 3rd Week	68 ± 42	37.22 ± 31.22	35 ± 21.21	48.54 ± 37.92	0.012
Weight At 4th Week	76.36 ± 41.54	42.5 ± 27.12	0 ± 0	62.11 ± 39.24	0.061
Weight At 5th Week	72.5 ± 49.92	13.33 ± 5.77	0 ± 0	47.14 ± 47.51	0.103
Total	24	61	13		

In our study we noticed time taken for reaching full spoon feeds,Length of hospital stay and weekly weight gain was statistically significant when analysis was done with different gestational age(30-31+^{6}weeks v/s 32-33^{+6}weeks v/s ≥ 34 weeks) except weight change in the first, fourth and fifth week

Table 14: Mean of outcome parameter amongst Birth weight groups

Parameter	Birth Weight (gms)			Total (N)	p-value
	≤1500 (n=42)	1501-2000 (n=51)	>2000 (n=5)		
Day Of Reaching Full Spoon Feeds	10.33 ± 5.58	6.9 ± 4.9	4.8 ± 4.44	8.27 ± 5.46	0.003
Length Of Hospital Stay in Days	20.48 ± 8.4	14.57 ± 5.31	10.4 ± 6.95	16.89 ± 7.54	<0.001
Weight At Enrolment	1275.95 ± 177.76	1709.61 ± 144.26	2136 ± 110.59	1545.51 ± 296.95	<0.001
Weight At 1st Week	-54.4 ± 42.36	-57.94 ± 25.62	-54 ± 21.91	-56.22 ± 33.46	0.871
Weight At 2nd Week	59.67 ± 44.72	61.39 ± 48.26	40 ± 28.28	60.15 ± 46.1	0.813
Weight At 3rd Week	55.77 ± 40.85	40.09 ± 31.98	10 ± 0	48.54 ± 37.92	0.199
Weight At 4th Week	72.67 ± 37.12	22.5 ± 12.58	0 ± 0	62.11 ± 39.24	0.018
Weight At 5th Week	53.33 ± 48.85	10 ± 0	0 ± 0	47.14 ± 47.51	0.449

In this study we obsereved that day of reaching full spoon feeds,length of hospital stay and weight gain at fourth week was statistically significant when analysis was done with different birth weight.

Table 15: Mean of outcome parameter amongst Gender

Parameter	Gender (Mean± SD)		Total (N)	p-value
	Male (n=57)	Female (n=41)		
Day Of Reaching Full Spoon Feeds	8.68 ± 5.73	7.68 ± 5.08	8.27 ± 5.46	0.373
Length Of Hospital Stay in Days	17.88 ± 7.69	15.51 ± 7.2	16.89 ± 7.54	0.126
Weight At Enrolment	1548.07 ± 321.52	1541.95 ± 262.86	1545.51 ± 296.95	0.920
Weight At 1st Week	-54.47 ± 33.47	-58.66 ± 33.71	-56.22 ± 33.46	0.544
Weight At 2nd Week	70.15 ± 48.9	46.31 ± 38.35	60.15 ± 46.1	0.013
Weight At 3rd Week	47.81 ± 34.63	50 ± 44.85	48.54 ± 37.92	0.843
Weight At 4th Week	67.5 ± 34.67	52.86 ± 47.51	62.11 ± 39.24	0.448
Weight At 5th Week	31.67 ± 26.39	140 ± 0	47.14 ± 47.51	0.013

In the current study day of reaching full spoon feeds, length of hospital stay, weight at enrolment and weight changes during the first, third, and fourth weeks showed no significant difference between male and female infants ($p = 0.373$, $p = 0.126$). However, weight gain at the second and fifth weeks showed statistically significant differences ($p = 0.013$).

DISCUSSION

Prematurity is a significant global concern, contributing to neonatal mortality and long-term complications, including feeding difficulties[19]. Preterm infants often struggle with coordinating sucking, swallowing, and breathing, leading to delayed oral feeding, poor weight gain, and prolonged hospital stays[19]. Given the critical need to reduce the time taken for the transition to full oral feeding, various interventions, including oromotor, olfactory stimulation and many have been explored to enhance feeding progression and improve nutritional outcomes[19]. Among these, olfactory stimulation with maternal breast milk has gained attention as a promising, non-invasive technique to support feeding development in preterm infants[20].

We enrolled 98 babies into the study. Forty-nine neonates were allocated to the intervention group and the another forty-nine to the control group. The objective of the study was to evaluate the effect of olfactory stimulation with breast milk on time taken to achieve full spoon feeds, weekly weight gain, and length of hospital stay in preterm neonates. There were no differences between the intervention and control groups with respect to maternal age, gender, gestational age, and birth weight (Table - 3, 4, 5, 6), thus indicating the study groups were comparable, which ensures that study results are due to the intervention and not related to differences in the study groups.

Our study results demonstrated a significantly shorter period to achieve full spoon feeds in intervention group (6.14 ± 3.52 days) compared to control group (10.39 ± 6.22 days, $p<0.001$) (Table-12), highlighting the effectiveness of breast milk odor stimulation in improving feeding progression. This finding is similar to report by Yildiz et al[4], Lee EJ[78] , Küçük Alemdar & İnal [77], and Davidson et al[61], all of which reported that olfactory stimulation significantly reduced transition time to full spoon

feeding ($p<0.05$). Additionally, the meta-analysis by Qin et al. confirmed a significant reduction in transition time with breast milk odor exposure ($p<0.00001$)[83].

The faster transition to full spoon feeds in intervention group suggests that breast milk odor may enhance feeding readiness by stimulating neural pathways associated with feeding reflexes. This observation is further supported by studies indicating that maternal milk odor promotes the sucking reflex, improves coordination of suck-swallow-breathe patterns, and reduces feeding stress in preterm infants.

In our study, infants in the control group lost more weight during the first week compared to the intervention group, which was statistically significant ($p<0.001$). In the second week, weight gain was significantly higher in the intervention group compared to the control group ($p=0.023$), but in the following weeks, there was no significant difference between the two groups (Table-10). This contrasts with most previous studies, such as Yildiz et al[4], Lee EJ[78] et al, Davidson et al61, Iranmanesh et al[82], and Beker et al[81], which reported no significant impact of breast milk odor stimulation on weight gain ($p>0.05$). However, our findings align with studies by Ahmed FA[44] and Mohammadi et al[85], which reported significant weight gain in preterm infants receiving breast milk odor stimulation ($p<0.05$). These differences in outcomes may be due to variations in feeding protocols, where in our study, both groups received feeds according to NICU guidelines, gradually increased to 140–160 ml/kg/day based on tolerance and weight gain. The olfactory stimulation in our study was provided three times daily (8 am, 2 pm, and 8 pm) for seven consecutive days using a cotton pad with 1 ml of the mother's breast milk placed near the infant's nose for five minutes. Additionally, sample characteristics such as gestational age (30–34 weeks), birth weight, and overall health status were relatively uniform in our study, whereas other studies included wider gestational ranges, more

critically ill neonates and different inclusion criteria, which may have influenced the outcomes.

While our study suggests a potential short-term weight gain advantage with breast milk odor exposure, the long-term benefits remain unclear. Future research should focus on standardizing olfactory stimulation protocols, evaluating its sustained impact on growth, and determining if early weight gain translates into better long-term neurodevelopmental outcomes.

In contrast to previous studies, our study findings showed a significant reduction in hospital stay duration between intervention group and control group ($p<0.001$)(Table-11). This contradicts results from Yildiz et al[4], Davidson et al[61], Iranmanesh et al[82], Beker et al[81], and Khodagholi et al[77], where no statistically significant difference in hospital stay duration was observed despite faster feeding transitions ($p>0.05$). The meta-analysis by Qin Y et al [83] also found no significant impact of breast milk odor stimulation on hospital discharge timing ($P = 0.86$).

Further studies are needed to determine if breast milk odor directly affects hospital stay duration or if other confounding factors are responsible for this outcome.

In our study, there was no statistically significant difference in mean birth weight between male and female neonates ($p=0.920$). During the second week, male infants gained significantly more weight than females ($p=0.013$), but by the fifth week, the rate of weight gain is same in both genders, with no sustained difference (Table-15). These findings are consistent with the results of Chou FS and Yeh HW[89], who observed that male neonates, particularly those born extremely preterm, tend to gain more weight in the early postnatal period, whereas female neonates exhibit increased growth rates later. This indicates that although males may initially gain

weight more rapidly, females typically show compensatory growth in the subsequent weeks.

Neonates with birth weight <1500g took significantly longer time to achieve full spoon feeds (p=0.003) and had longer hospital stays (p<0.001)(Table-14).These results align with studies indicating that lower birth weight infants have delayed oral feeding readiness and require more supportive interventions[90].

Preterm neonates (30–31 weeks) had significantly longer hospital stays and delayed feeding milestones compared to those born ≥34 weeks (p<0.002)(Table-13).Studies on neonatal neurodevelopment confirm that greater gestational maturity is associated with faster feeding transition and weight gain stability[91].

STRENGTHS AND LIMITATIONS

STRENGTHS

- The study utilized a randomized clinical trial design, reducing bias and improving the reliability of findings.
- The intervention was delivered by mothers and nurses, demonstrating feasibility, acceptability and encouraging mothers involvement along with trained healthcare staff in neonatal care.
- Significant improvements were observed, including a shorter transition time to full spoon feeds and reduced hospital stay, highlighting the effectiveness of intervention.
- Key outcomes such as time to full spoon feeds, weekly weight gain, and hospital stay duration were meticulously monitored, resulting in accurate data collection.
- The study provided valuable insights into the effect of olfactory stimulation on feeding progression in preterm infants, an area with limited research.

LIMITATIONS

- The study was conducted in a single center, which may limit the generalizability of the findings to a general population.
- The sample size of 98 participants is relatively small, requiring larger multicenter trials for validation.
- Another limitation is that feeding and stimulation methods differed from those used in other studies. In our study, feeds were gradually increased based on each baby's tolerance, while other studies varied in how often and how long breast milk smell was given, as well as the amount used. These differences can affect outcomes like weight gain and hospital stay, making it difficult to compare results. Using similar methods in future studies would help to get more reliable data and study results.
- The study focused on immediate feeding outcomes, without long-term follow-up on feeding success and neurodevelopmental effects.
- Infants with severe medical conditions such as necrotizing enterocolitis and congenital anomalies were excluded, limiting the application of findings to high-risk neonates

CONCLUSION

Our study supports the role of breast milk odor stimulation in accelerating oral feeding transition and promoting early weight gain. While we observed a shorter hospital stay in the intervention group, these finding contrasts with most previous studies, suggesting that additional institutional and medical factors may contribute to discharge timing. Future studies should explore long-term developmental outcomes, standardized protocols, and potential interactions with other neonatal care strategies to optimize feeding and growth in preterm infants.

SUMMARY

- A randomized trial was conducted from April 2023 to March 2024 in the Department of Pediatrics, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre; Belagavi affiliated to JN Medical College, Belagavi. The study included 98 preterm infants with a gestational age between 30 and 34 weeks to evaluate feeding progression, weekly weight gain and duration of hospital stay.
- In the intervention group, 40.82% of infants were female and 59.18% were male, while in the control group, 42.86% were female and 57.14% were male.
- Gestational age was between 32 and 33+6 weeks for most infants in both groups, with no significant difference in distribution(p=0.310)
- Most infants had a birth weight between 1501-2000 grams, and thebirth weight distribution was also comparable between the groups without statistical significance(p=0.896)
- The average transition time from gavage feeding to full spoon feeds was significantly shorter in the intervention group 3.8 days, (SD = 2.52) compared to the control group 8.27 days(SD = 5.18).
- The average hospital stay was 13.9 days (SD = 5.28) in the intervention group, which was significantly shorter than the 19.88 days (SD = 8.3) observed in the control group. Statistically significant differences were also noted across different gestational age and birth weight categories.
- During the first week, infants in the control group experienced greater weight loss compared to those in the intervention group ($p < 0.001$). In the second week, weight gain was significantly higher in the intervention group than the

comparison group ($p = 0.023$), whereas no significant differences were observed for the other weeks.

- Infants born at 34 weeks reached full spoon feeds significantly earlier than those born at lower gestational ages ($p = 0.002$). The longest hospital stay was recorded for infants born between 30 and 31+6 weeks ($p < 0.001$). Birth weight also influenced feeding progression, with lower birth weight infants taking significantly longer to achieve full spoon feeds ($p = 0.003$) and stayed in the hospital for longer period ($p < 0.001$).
- The findings of this study shows that infants in the intervention group had a faster feeding progression and shorter hospital stay. Additionally, higher gestational age and birth weight were linked to improved feeding outcomes.

BIBLIOGRAPHY

1. World Health Organization. Preterm birth .Geneva: WHO; 2024.
2. Ohuma E, Moller AB, Bradley E. National, regional, and worldwide estimates of preterm birth in 2020, with trends from 2010: a systematic analysis.Lancet.2023;402(10409):1261-1271.doi:10.1016/S0140-.6736(23)00878-4.
3. Shaki F, Aziznejadroshan P, Rad ZA, Chehrazi M, Arzani A. Comparison of the effect of two methods of sucking on pacifier and mother's finger on oral feeding behavior in preterm infants: a randomized clinical trial. BMC Pediatr. 2022;22(1):292-298. doi:10.1186/s12887-022-03352-9.
4. Yildiz A, Arikan D, Gozum S, Taştekın A, Budancamanak I. The effect of the odor of breast milk on the time needed for transition from gavage to total oral feeding in preterm.J Nurs Scholarsh. 2011;43(3):265-273. doi:10.1111/j.1547-5069.2011.01410.
5. Bingham PM, Churchill D, Ashikaga T. Breast milk odor via olfactometer for tube-fed,premature infants.Behav Res Methods.2007;39(3):630-640. doi:10.3758/bf03193035.
6. Perin J,Mulick A,Yeung D,Villavicencio F,Lopez G,Strong KL,et al. Global, regional, and national causes of under-5 mortality in 2000–19: an updated systematic analysis with implications for the Sustainable Development Goals. The Lancet Child and Adolescent Health. 2022;6(2):106-115.
7. Stoll BJ, Hansen NI, Bell E, Walsh MC, Carlo WA, Shankaran S, et al. Trends in Care Practices, Morbidity and Mortality of Extremely Preterm Neonates.JAMA.2015;31(4):1039–1051.

8. Kamity R, Kapavarapu PK, Chandel A. Feeding Problems and Long-Term Outcomes in Preterm Infants-A Systematic Approach to Evaluation and Management.Children.2021;8(12):1158-1160. doi:10.3390/children8121158.
9. West-Eberhard MJ. Developmental plasticity and the origin of species differences. Proc Natl Acad Sci U S A. 2005;102(1):S6543-S6549. doi:10.1073/pnas.0501844102
10. Chandrasekharan P, Rawat M, Lakshminrusimha S. Complications of prematurity:aninfographic.JPerinatol.2017;37(11):1185-1186.PMID:29138522
11. Viswanathan S, Jadcherla SR. Feeding and swallowing difficulties in neonates: Developmental physiology and pathophysiology. Clin Perinatol. 2020;47(2):223–241.
12. Lau C, Schanler RJ. Oral motor function in the neonate. Clinics in Perinatology.1996;23(2):161–178.
13. Sameroff AJ. The components of sucking in the human newborn. J Exp Child Psychol. 1968;6(4):607-623. doi:10.1016/0022-0965(68)90106-9
14. Wolff PH. The serial organization of sucking in the young infant. Pediatrics. 1968;42(6):943-56. PMID: 4235770
15. Wolf LS, Glass RP. Feeding and swallowing disorders in infancy: Assessment and management. Tucson, AZ: Therapy Skill Builders; 1992
16. Lau C, Sheena HR, Shulman RJ, Schanler RJ. Oral feeding in low birth weight infants. J Pediatr. 1997;130(4):561-569. doi:10.1016/s0022-3476(97)70240-3
17. Lau C. Development of suck and swallow mechanisms in infants. Ann Nutr Metab. 2015;66(5):S7–S14.PMID:26226992.
18. Hack M, Estabrook MM, Robertson SS. Development of sucking rhythm in preterm infants. Early Hum Dev. 1985;11(2):133-140. doi:10.1016/0378-3782(85)90100-8

19. Hafstrom M, Kjellmer I. Non-nutritive sucking in sick preterm infants. Early Hum Dev. 2001;63(1):37-52. doi:10.1016/s0378-3782(01)00146-3

20. Lundqvist C, Hafstrom M. Non-nutritive sucking in full-term and preterm infants studied at term conceptional age. Acta Paediatr. 1999;88(11):1287-89. doi:10.1080/080352599750030455

21. Neiva FC, Leone C, Leone CR. Non-nutritive sucking scoring system for preterm newborns. Acta Paediatrica.2008;97(10):1370–1375.PMID:24964303.

22. Miller JL, Kang SM. Preliminary ultrasound observation of lingual movement patterns during nutritive versus non-nutritive sucking in a premature infant. Dysphagia.2007; 22(2): 150–160.

23. Wrotniak BH, Stettler N, Medoff-Cooper B. The relationship between birth weight and feeding maturation in preterm infants. Acta Paediatr. 2009;98(2):286-290

24. Cunha M, Barreiros J, Gonçalves I, Figueiredo H. Nutritive sucking pattern-from very low birth weight preterm to term newborn. Early Hum Dev. 2009;85(3):125-130

25. Da Costa SP, van der Schans CP, Zweens M. The development of sucking patterns in preterm, small-for-gestational age infants. J Pediatr. 2010;157(4):603-609.PMID:20542296.

26. Da Costa SP, van der Schans CP. The reliability of the Neonatal Oral-Motor Assessment Scale. Acta Paediatr. 2008;97(4):21-26.

27. Pineda R, Dewey K, Jacobsen A, Smith J. Non-Nutritive Sucking in the Preterm Infant. Am J Perinatol. 2019;36(3):268-276. doi: 10.1055/s-0038-1667289.

28. Lau C, Alagugurusamy R, Schanler RJ, Smith EO, Shulman RJ. Characterization of the developmental stages of sucking in preterm infants during bottle feeding. Acta Paediatr. 2000;89:846–852.
29. Amaizu N, Shulman R, Schanler R, Lau C. Maturation of oral feeding skills in preterm infants. Acta Paediatr. 2008;97:61–67.
30. Fucile S, McFarland DH, Gisel EG, Lau C. Oral and non oral sensorimotor interventions facilitate suck-swallow-respiration functions and their coordination in preterm infants. Early Hum Dev. 2012;88:345–350.
31. Sameroff AJ. The components of sucking in the human newborn. J Exp Child Psychol. 1968;6:607–623.
32. Pruksadee N, Daramas T, Phumolsakul S.Effect of the Premature Infant Oral Motor Intervention on Transition Time from Tube to Oral Feeding and Body Weight.Nurs Res Inno J.2017;23(3):257-268.
33. Arora S. Effect of oromotor stimulation on feeding progression in preterm infants. Journal of Neonatal Nursing.2020;10(12):2249-2251
34. Lau C, Smith EO. Interventions to improve the oral feeding performance of preterm infants. Acta Paediatr. 2012;101:e269–274.
35. Lau C, Fucile S, Schanler RJ. A self-paced oral feeding system that improves preterm infants' oral feeding skills. J Neonatal Nurs. 2015;21:121–126.
36. Fucile S, Gisel EG, McFarland DH, Lau C. Oral and non-oral sensorimotor interventions enhance oral feeding performance in preterm infants. Dev Med Child Neurol. 2011;53(9):829–835.
37. Maron JL.Insights into neonatal oral feeding through the salivary transcriptome. Int J Pediatr. 2010;12:1-7

38. Meier PP, Johnson TJ, Patel AL, Rossman B. Evidence-Based Methods That Promote Human Milk Feeding of Preterm Infants: An Expert Review. Clin Perinatol. 2017;44(1):1-22. doi: 10.1016/j.clp.2016.11.005.

39. Dodrill P, Gosa MM. Pediatric Dysphagia: Physiology, Assessment, and Management.AnnNutrMetab.2015;66(5):S243-S251. doi:10.1159/000381372

40. Jadcherla S. Dysphagia in the high-risk infant: Potential factors and mechanisms. Am J Clin Nutr. 2016;103:622–628

41. Anuk Ince D, Takci S, Kilicdag H, Turan O. Editorial: Feeding difficulties in newborn infants and new approaches in practice. Front Pediatr.2024;12:1-3.doi:10.3389/fped.2024.1462493.

42. Lau C. To Individualize the Management Care of High-Risk Infants With Oral Feeding Challenges: What Do We Know? What Can We Do? Front Pediatr. 2020;8:296-299. doi: 10.3389/fped.2020.00296.

43. Séassau A, Munos P, Gire C, Tosello B, Carchon I. Neonatal Care Unit Interventions on Preterm Development.Children.2023;10(6):999-1014. doi:10.3390/children10060999

44. Lavallee A, Aita M, Cote J, Bell L, Grou B. Promoting Sensitive Mother-Infant Interactions in the Neonatal Intensive Care Unit: Development and Design of a Nursing Intervention Using a Theory and Evidence-Based Approach. Sci Nurs Health Pract. 2022;5:48-75.

45. Maron JL. Computational gene expression modeling identifies salivary biomarker analysis that predict oral feeding readiness in the newborn. Int J Pediatr. 2015;166(2):282-288.

46. 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.

47. Lessen Knoll BS, Daramas T, Drake V. Randomized Controlled Trial of a Prefeeding Oral Motor Therapy and Its Effect on Feeding Improvement in a Thai NICU. J Obstet Gynecol Neonatal Nurs. 2019;48(2):176-188

48. Arora K, Goel S, Manerkar S, Konde N, Panchal H, Hegde D, et al. Prefeeding oromotor stimulation program for improving oromotor function in preterm infants-A Randomized controlled trial. Indian Pediatr. 2018;55(8):675-678.

49. Calk P. Best practices for oral motor stimulation to improve oral feeding in preterm infants: A systematic review. Ann Physiother Occup Ther. 2019;2(5):01-14

50. Abd Elrazek FA, Abo Zaid DE, Hassan RA. Effect of Abdominal Massage on Feeding Intolerance and Weight of Preterm Neonates. Egypt J HealthCare. 2022;13(4):1725-1736

51. Pickler RH, Meinzen-Derr J, Moore M, Sealschott S, Tepe K. Effect of Tactile Experience During Preterm Infant Feeding on Clinical Outcomes. Nurs Res. 2020;69(5):S21-S28

52. Vidhyasagar K, Kamalakannan SK, Kumar BR, Azhagar V, Santhi N. Effectiveness of vestibular stimulation on weight gain in preterm infants. J Chem Health Risks. 2024;14(2):1870-1875.

53. Vance DE, Del Bene VA, Kamath V, Frank JS, Billings R, Cho DY et al. Does Olfactory Training Improve Brain Function and Cognition? A Systematic Review. Neuropsychol Rev. 2024;34(1):155-191. doi: 10.1007/s11065-022-09573-0.

54. Gilad Y, Bustamante CD, Lancet D. Natural selection on the olfactory receptor gene family in humans and chimpanzees. Am J Hum Genet. 2003;73:489–501.

55. Glusman G, Yanai I, Rubin I. The complete human olfactory subgenome. Genome Res. 2001;11:685–702.

56. Schaal B, Hummel T, Soussignan R. Olfaction in the fetal and premature infant: Functional status and clinical implications. Clin Perinatol. 2004;31(2):261-285.

57. Chuah MI, Zheng DR. Olfactory marker protein is present in olfactory receptor cells of human fetuses. Neuroscience. 1993;23: 377-389.

58. Bartocci M. Activation of olfactory cortex in newborn infants after odor stimulation: A functional near-infrared spectroscopy study. Pediatr Res. 2000;48:18-23.

59. Marlier L, Gaugler C, Astruc D. Olfactory sensitivity of the premature newborn. Arch Pediatr. 2007;14(1):45-53.

60. Marlier L, Schaal B. Human newborns prefer human milk: Conspecific milk odor is attractive without postnatal exposure. Child Dev. 2005;76(1):155-168.

61. Davidson J, Ruthazer R, Maron JL. Optimal Timing to Utilize Olfactory Stimulation with Maternal Breast Milk to Improve Oral Feeding Skills in the Premature Newborn. Breastfeed Med. 2019;14(4):230-235

62. Pavlov I. Nobel Lecture: Physiology of Digestion. Nobel Media AG, 1904

63. Power ML, Schulkin J. Anticipatory physiological regulation in feeding biology: cephalic phase responses. Appetite. 2008;50(3):194-206

64. Stark R. Exploring the role of the olfactory bulb in feeding and metabolism. J Neurorndocrinol.2024;36(2):e13832.doi:10.1111/jne.13832.

65. Muelbert M, Lin L, Bloomfield FH, Harding JE. Exposure to the smell and taste of milk to accelerate feeding in preterm infants. Cochrane Database Syst Rev. 2019;7:CD013038.

66. Louyeh ZS, Naderifar M, Faghihi H, Knoll BSL, Mahmoodi N. Comparing the effect of breast milk odor and incubator cover on nutritional adequacy of premature infants: a quasi-experimental study. Med Surg Nurs J. 2020;9(2):e99-e103.

67. Akcan E, Polat S. Comparative effect of the smells of amniotic fluid, breast milk, and lavender on newborns' pain during heel lance. Breastfeed Med. 2016;11(6):309-314

68. Altmier L, Phillips R. The neonatal integrative developmental care model: advanced clinical applications of the seven core measures for neuroprotective family-centered developmental care. Newborn Infant Nurs Rev. 2016;16(4):230-244

69. Hym C, Forma V, Anderson DI, Provasi J, Granjon L. Newborn crawling and rooting in response to maternal breast odor. Dev Sci. 2021;24(3):e130-61

70. Gaeta G, Wilson DA. Reciprocal relationships between sleep and smell. Front Neural Circuits. 2022;16:1076354

71. Haller RL, Gaylord L, Aizenman E, et al. Olfactory exposure to maternal breast milk enhances oral feeding in preterm infants. J Perinatol. 2023;43(3):469-478.

72. Marlier L, Gaugler C, Messer J. Olfactory stimulation and preterm infant feeding behavior. Chem Senses. 2018;43(7):469-478.

73. Arzi A, Holtzman Y, Shilo L, et al. Impaired olfactory function in children with mild traumatic brain injury. Brain Inj. 2024;8(2):159-172.

74. Marino BS, Lipkin PH, Newburger JW, et al. Neurodevelopmental outcomes in children with congenital heart disease: Evaluation and management. Circulation. 2019;139(8):e526-e565.

75. Olfactory stimulation for promoting development and preventing morbidity in preterm infants. Cochrane Database Syst Rev. 2022;4(4):CD013629.

76. Olfactory Stimulation Prevents Apnea in Premature Newborns. Pediatrics. 2005;115(1):83-88.

77. Khodagholi Z, Zarifian T, Soleimani F, Khoshnood Shariati M, Bakhshi E. The effect of non-nutritive sucking and maternal milk Odour on the independent oral feeding in preterm infants. Iran J Child Neurol. 2018;12(4):55-64

78. Lee EJ. The effects of breast milk olfactory stimulation on physiological responses, oral feeding progression and body weight in preterm infants. J Korean Acad Nurs. 2019;49(2):126–136.

79. Kucuk Alemdar D, Inal S. The effect of individualized developmental care practices in preterm infants. Complement Med Res. 2020;27(2):97–104.

80. Le Q, et al. Effects of olfactory and taste stimulation on tube-fed premature infants. J Nurs. 2021;36(19):32–34.

81. Beker F, et al. Effects on growth of smell and taste of milk during tube feeding of preterm infants: A randomized clinical trial. JAMA Pediatr. 2021;175(11):1115–1123.

82. Iranmanesh S, Shamsi A, pour Aboli B, Movahedi Z. The Effect of Breast Milk Odor on Transition Time From Gavage to Oral Feeding and Hospital Stay in Premature Infants. ICAN. 2015;7(1):5-11

83. Qin Y, Liu S, Yang Y, Zhong Y, Hao D, Han H. Effects of human milk odor stimulation on feeding in premature infants: a systematic review and meta-analysis. Sci Rep. 2024;14(8964). doi:10.1038/s41598-024-59175-4.

84. Ahmed FA. Breast Milk Odor Effect on Weight Gain, First Breastfeeding Time and Length of Hospital Stay in Premature Infants.IOSR J Nurs Health Sci 2019;8(3):42–49

85. Mohammadi R, Soleimani F, Boroujeni ST, Mohammadizadeh M. Effect of breast milk olfactory stimulation on behavioral responses and feeding progression of preterm neonates. J Matern Fetal Neonatal Med. 2021;34(19):3201-3208. doi:10.1080/14767058.2019.1690681.

86. Badiee Z, Asghari M, Mohammadizadeh M. The calming effect of maternal breast milk odor on premature infants. J Pediatr Nurs. 2021;57:96-101. doi:10.1016/j.pedn.2020.10.010.

87. Ranjbar S, Taheri P, Abdeyazdan Z, Pourarian S. Effect of olfactory stimulation with breast milk on pain responses to heel stick in premature infants: A randomized controlled trial. Breastfeed Med. 2022;17(5):318-324. doi:10.1089/bfm.2021.0374.

88. Zeraatian S, Alinejad-Naeini M, Sadeghnia A, Seifi S, Bagheri S. The effect of breast milk odor on infant pain and stress levels. BMC Pediatr. 2025;25(1):112-114. doi:10.1186/s12887-025-05504-z.

89. Chou FS, Yeh HW. Sex differences in postnatal weight gain trajectories of extremely preterm newborns. J Perinatol. 2021;41(8):1835-1844. doi: 10.1038/s41372-021-01099.

90. Jadcherla, S., Wang, M., Vijayapal, A. et al. Impact of prematurity and co-morbidities on feeding milestones in neonates: a retrospective study. J Perinatol.2010; 30: 201–208.

91. Park J, Knafl G, Thoyre S, Brandon D. Factors associated with feeding progression in extremely preterm infants. Nurs Res. 2015 ;64(3):159-167. doi: 10.1097/NNR.0000000000000093.

ANNEXURES

ANNEXURE – I - INFORMED CONSENT FORM

''EFFECT OF BREAST MILK ODOUR ON TIME NEEDED TO ACHIEVE FULL SPOON/PALADAI FEEDING IN PRETERM BABIES - ONE YEAR HOSPITAL BASED RANDOMISED STUDY''

Name of Student/Principal Investigator: _____

Name of Guide: _____

Name of Co- Guide: _____

Introduction: We invite you and your baby to participate in the study. The olfactory sense is one of the most developed in human senses. It is active in the embryonic period and after birth, the olfactory sense helps in digestion, development of sucking reflex, and guides an inexperienced infant to start feeding. The olfactory sense not only causes a sense of enjoyment and satisfaction, but it also seems necessary to start sucking trough sensory signals received by the brain. By repetitions of this experience feeding capabilities of newborn develop and time taken for achievement of full spoon feeding becomes shorter, resulting in early discharge from the hospital.

Explanation of procedure: Olfactory stimulation is performed with cotton pads impregnated with one ml of mother's breast milk. If mother's breast milk is not available cotton placed on the mother's breast for five minutes will be used for intervention. The cotton pad is placed near the infant's nose (1.5-2cm) for five minutes. This is performed three times a day for seven days.

Cotton pads will be checked to ensure that they don't have any odor that would cause any interference with olfactory stimulation

Withdrawal from participation in the study: Participation in this study in voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You may or may not get any benefits by participating in this study. The data gathered will help population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Cost of investigations: Not applicable.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purpose and or presented to scientific groups. However, your identity will never be revealed.

Questions: In case of any questions regarding this study, you are free to contact:

If you have any question or complaints with regard to your right as study participant you may contact Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

STATEMENT OF CONSENT

I hereby voluntarily agree to my newborn baby's participation in the study, **"'EFFECT OF BREAST MILK ODOUR ON TIME NEEDED TO ACHIEVE FULL SPOON/PALADAI FEEDING IN PRETERM BABIES - ONE YEAR HOSPITAL BASED RANDOMISED STUDY''.** I understand that even if I choose to allow my newborn baby to take part in this study, I have the liberty to withdraw at any time. My signature below indicates that I have read or have been told about this entire consent form including the risks and benefits and have had all my questions answered. I will be given a copy of this consent form.

Signature or left thumb impression of the parent : _____

Date : _____

Name : _____

Relation to the subject : _____

Signature or left thumb impression of the witness : _____

Date : _____

Name : _____

Signature of the investigator : _____

Date : _____

Name : _____

ANNEXURE – II - PROFORMA

Effect of breast milk odour on time needed to achieve full spoon/paladai feeding in preterm babies- one year hospital based randomized study

Principal Investigator: _____

Guide: _____

Co Guide: _____

SUBJECT NO: _____ IP No:_____

MATERNAL INFORMATION

1) Name:

2) Age:

3) Permanent address:

4) Telephone No.:

5) LMP: EDD: Gestational age (weeks):

NEONATAL INFORMATION:

1) Date of birth:___/___/_____

2) Study group: A ☐ B: ☐

3) Gestational age: _____weeks 4)Age at enrollment:

5)Sex: Male/Female

6)Birth weight (grams):_____gm

7)Weight at enrolment:_____ gm

8)Any major congenital anomalies:YES/NO

9)Intra ventricular hemorrhage- YES/NO, if YES, Grade-_____

10)Necrotizing enterocolitis-YES/NO, if YES, Stage-_____

11)Perinatal Asphyxia – YES/NO, if YES, Stage-_____

12)Any condition where oral feeding is contraindicated – YES/NO, if YES_____

13)		Partial spoon feed(days)	Full spoon feed(days)
	Transition from gavage to full oral feed		

14)	1st Week	2nd Week	3rd Week	4th Week
Weight(Kg)				
Weight gain				

15) Duration of hospital stay-_____Days

ANNEXURE III-MASTER CHART

Subject No.	Group	In-patient no.	Name	Maternal Age(yrs)	Gender	Gestation (weeks +days)	Birth weight(gm)	Day of enrollment	Weight at enrollment(gm)	Intiation of tube feeds (Day of life)	Initiation of spoon feeds(tube +Spoon)(Day of life)	Full spoon feeds(Day of life)	Transition time to full oral feeds(SF) (days)	Length of hospital stay in days	Weight Gain (gm)					
															1st Week(Day1-7)	2nd Week(Day8-14)	3rd Week(Day15-21)	4th Week(Day22-28)	5th Week(Day29-35)	
1	B	1203145	B/O AW	27	Female	31wks+1d	1200			4	6	11	7	11	-60	60	_	_	_	
2	A	1204112	B/O AMB	25	Male	32wks +2d	1500	1	1200	1	2	3	2	18	-50	80	24(day 18)	_	_	
3	B	1207148	B/O JMJ	24	Male	32wks+6d	1700	1	1500	1	_	_	_	23	-70	8	12(died-day21)	_	_	
4	B	1208224	B/O M	23	Female	33wks+2d	1500	7	1700	1	3	8	7	14	-80	20	_	_	_	
5	A	10006940	B/O KSL	20	Female	33wks+2d	1840	2	1500	1	1	4	3	6	-40	_	_	_	_	
6	A	10007901	B/O YPP	32	Male	32wks+1d	1300	1	1820	4	7	8	4	17	-50	40	120(day 17)	_	_	
7	A	10007713	B/O SR	34	Male	31wks+1d	1900	2	1300	5	11	13	7	16	-60	120	20(day 16)	_	_	
8	B	10007953	B/O PVT	25	Male	33wks+6d	1600	1	1900	1	4	7	6	14	-70	100	_	_	_	
9	B	10007946	B/O P	20	Female	32wks	1300	2	1480	3	4	7	5	20	-75	60	20(day 20)	_	_	
10	B	10010093	B/O LSK T1	24	Female	32wks+5 d	1520	1	1300	2	3	7	5	17	-55	100	10(day 17)	_	_	
11	B	10010094	B/O LSK T2	24	Male	32wks+5d	1600	1	1520	5	14	24	19	31	-80	40	120	20	10(day 31)	
12	A	10010967	B/OMHH	21	Male	32wks+2d	1700	1	1600	1	6	9	3	16	-50	140	40(day16)	_	_	
13	B	10011660	B/O PB	23	Male	33wks+1d	1900	1	1700	1	2	6	5	13	-70	20	_	_	_	
14	A	10012846	B/O S	27	Male	32wks+3d	1600	1	1900	1	5	6	5	13	-50	180	_	_	_	
15	B	10022894	B/O S	24	Female	33wks+3d	1600	1	1600	1	10	15	14	21	-60	40	100	_	_	
16	B	10025368	B/O M T1	23	Female	34wks	1900	2	1600	_	1	_	1	10	-50	10(day 10)	_	_	_	
17	B	10025369	B/O M T2	23	Male	34wks	1600	1	1900	1	5	10	9	13	-100	40	_	_	_	
18	B	10028566	B/O S	27	Male	33wks+6d	1600	2	1600	1	2	6	5	12	-80	60(day 12)	_	_	_	
19	B	10031146	B/O IB	20	Male	33wks	1600	1	1600	1	2	6	5	21	-70	120	40	_	_	
20	B	10031849	B/O RT	27	Male	30wks+1 d	1040	1	1600	3	4	9	6	35	-60	40	120	120	20(day35)	
21	B	10032686	B/O FP	25	Female	31wks+3d	1020	3	1040	5	7	17	12	37	-75	10	40	120	140	
22	A	10033294	B/O MN	27	Male	32wks+6d	1700	7	1020	1	2	4	3	13	-50	80	_	_	_	
23	B	10033836	B/O SH	25	Female	34wks	1900	2	1700	2	4	6	4	11	-50	10	_	_	_	

24	A	10035981	B/O KV	34	Male	34wks	1950	2	1880	2	3	5	3	8	30	20	_	_	_	
25	B	10036522	B/O KSL	24	Female	32wks+4d	1600	1	1950	2	8	24	22	27	-100	40	50	10(day 27)	_	
26	A	10037023	B/O J T1	24	Male	32wks+2d	1100	2	1580	6	7	8	2	15	-20	100	20(day 15)	_	_	
27	A	100378815	B/O VP	23	Female	33wks+3d	1700	2	1100	2	2	4	2	8	-50	10(Day8)	_	_	_	
28	A	10051388	B/O RB	25	Female	30wks	1300	1	1700	5	8	14	9	21	-40	70	120	_	_	
29	A	10052970	B/O SP	34	Female	33wks+5d	1400	1	1300	2	4	5	3	10	-30	90	_	_	_	
30	B	10053071	B/O VG	23	Male	33wks+4d	1760	2	1400	1	2	4	3	11	-50	40(day 11)	_	_	_	
31	B	1005236	B/O LA	28	Male	33wks	1280	1	1760	2	6	14	12	21	-70	80	20	_	_	
32	B	10055756	B/O KH	26	Female	34wks	1680	1	1280	_	_	1	1	12	-40	20	_	_	_	
33	A	10057309	B/O LL	24	Male	32wks	1740	1	1680	5	8	10	5	16	-30	80	20(day 16)	_	_	
34	B	10059828	B/O S	29	Female	33wks+1d	1400	2	1740	4	8	14	10	24	-80	60	30	10(day 24)	_	
35	A	10061935	B/O PG	21	Female	34wks	1500	1	1400	2	3	4	2	8	80	20(day 8)	_	_	_	
36	B	10063326	B/O SB	22	Female	33wks+2d	1500	2	1500	3	4	10	7	13	-50	30(day 13)	_	_	_	
37	A	10058405	B/O AS	24	Female	34wks	2100	3	1500	_	1	1	1	5	-50	_	_	_	_	
38	B	10060652	B/O LD	21	Female	33wks+2d	1930	1	2100	2	3	7	5	15	-90	20	_	_	_	
39	A	10062310	B/O GS	29	Female	31wks+5d	1360	1	1930	7	8	9	2	23	-40	60	100	30(day 23)	_	
40	B	10063608	B/O J	25	Female	33wks+4d	1500	4	1360	5	7	10	5	28	-80	80	20	40(day 28)	_	
41	B	10064094	B/O SS	39	Male	34wks	1890	3	1500	1	2	6	5	18	-60	30	20(day 18)	_	_	
42	B	10066174	B/O RA	25	Male	32wks	2090	1	1890	1	2	6	5	6	-50	_	_	_	_	
43	A	10064461	B/O AA	24	Male	32wks+5d	1540	2	2070	1	3	4	3	7	-20	_	_	_	_	
44	A	10066948	B/O JDD	32	Male	31wks+4d	1400	2	1530	3	8	11	8	15	-30	40	10(day 15)	_	_	
45	A	10067043	B/O SMS T1	30	Male	32wks+5d	1300	3	1390	4	6	7	3	17	-50	120	50(day 17)	_	_	
46	A	10067044	B/O SMS T2	30	Male	32wks+5 d	1640	2	1260	2	6	6	4	17	-40	100	70(day 17)	_	_	
47	A	10068011	B/O VR	29	Female	32wks+6d	1600	2	1640	2	6	11	9	14	-50	10	20	_	_	
48	A	10069130	B/O MSB	24	Male	30wks+3d	1460	2	1600	5	11	12	7	28	-35	10	40	60	_	
49	A	10067567	B/O RN T1	21	Male	33wks+6d	1760	6	1460	1	2	3	2	8	-50	60(day 8)	_	_	_	
50	A	10070204	B/O RN T2	21	Male	33wks+6d	1600	2	1760	1	2	3	2	12	-55	60(day12)	_	_	_	
51	A	10071615	B/O RR	24	Female	33wks	1600	3	1600	1	2	3	2	11	-60	20(day 11)	_	_	_	
52	A	10075758	B/O S	30	Female	32wks	1760	1	1580	3	7	8	5	15	-20	20	20(day 15)	_	_	
53	A	10076517	B/O P	37	Female	33wks+2d	1560	7	1460	2	2	4	2	11	-30	100(day11)	_	_	_	
54	A	10077248	B/O R	22	Male	31wks+1d	1420	1	1560	4	6	7	3	16	-80	140	80(day 16)	_	_	
55	B	10077803	B/O R	35	Male	32wks+5d	1560	3	1400	2	3	6	4	10	-70	10(day 10)	_	_	_	
56	B	10078316	B/O J	27	Male	34wks	1220	2	1560	1	4	7	6	14	-60	90	_	_	_	
57	B	10071950	B/O PN	24	Male	32wks+2d	1620	3	1180	3	4	15	12	21	-80	40	20	_	_	
58	B	10078199	B/O SA	24	Male	33wks+5d	920	2	1580	2	18	22	20	35	-100	80	40	80	20(Day 35)	
59	A	10080646	B/O K	33	Female	31wks+1d	1400	3	920	2	_	_	_	10(death)	-60	-30	_	_	_	
60	B	10080969	B/O TP	30	Female	32wks+4d	1900	2	1180	1	4	10	9	16	-110	80	20(day 16)	_	_	
61	A	10081186	B/O ST T2	22	Female	31wks+5d	1200	3	1890	1	3	4	3	11	-50	80(day 11)	_	_	_	
62	A	10082584	B/O RB	20	Male	33wks+5d	1200	2	1200	2	3	4	2	22	40	40	20	50(day 22)	_	
63	A	10086976	B/O NSG	32	Male	33wks+5d	2300	1	1200	1	1	2	1	6	-30	_	_	_	_	
64	A	10087518	B/O T T1	20	Male	30wks+5d	1250	1	2300	3	6	7	4	16	-20	130	20(day 16)	_	_	
65	A	10087501	B/O T T2	20	Male	30wks+5d	1020	2	1240	4	8	10	6	16	-50	40	30(day16)	_	_	

66	A	10088081	B/O SS	22	Male	31wks+1d	1400	4	1020	4	7	8	4	18	-40	10	30(day 18)	_	_	communicating hydrocephalous)
67	B	10088595	B/O D	27	Male	32wks+3d	1100	3	1380	8	11	30	22	31(AMA)	-70	70	95	70	10(day31)	
68	B	10004679	B/O MA	23	Female	33wks+2d	1500	2	1080	1	2	8	7	14	-100	96	_	_	_	
69	B	10007946	B/O P	20	Female	32wks+3d	1300	1	1500	3	4	8	5	20	-120	60	20(day 20)	_	_	
70	B	10092149	B/O AMT T1	30	Male	31wks+1d	1500	1	1300	1	4	11	10	21	-80	20	20	_	_	
71	B	10092150	B/O AMT T2	30	Male	31wks+1d	1500	2	1480	2	3	12	10	21	-90	60	40	_	_	
72	A	10008851	B/O RSL	38	Male	32wks+5d	1500	3	1470	1	2	5	4	11	-50	200(day 11)	_	_	_	
73	B	10094692	B/O DT	25	Female	30wks+1d	1000	1	1500	1	9	15	14	33	-70	-20	100	120(day33)	_	
74	A	10096072	B/O MB	29	Female	30wks+3d	1300	2	980	3	13	13	10	24	-80	-20	160	40(day 24)	_	
75	A	10097772	B/O BA	22	Female	34wks	2000	6	1280	_	_	_	1	7	-40	10	_	_	_	
76	A	10098774	B/O ST	24	Female	32wks+6d	1650	1	2000	4	5	6	2	14	-30	140	20	_	_	20(day 38)
77	B	10053271	B/O DR	20	Male	30wks+3d	1100	2	1620	2	11	17	15	38	-100	60	80	120	60	
78	A	10081186	B/O ST T1	22	Female	31wks+5d	1200	3	980	1	3	8	7	11	-40	60(day 11)	_	_	_	
79	A	10067675	B/O R T3	21	Male	33wks+6d	1760	2	1200	1	2	3	2	12	-80	200(day 12)	_	_	_	
80	B	10105344	B/O ST	26	Male	34wks+4d	2000	2	1760	1	1	3	2	9	-60	10(day 9)	_	_	_	10(day 39)
81	B	10102062	B/O S	30	Male	30wks+1d	1160	1	2000	2	7	16	14	39	-80	40	80	60	70	
82	A	10106443	B/O HK	23	Female	32wks+3d	1740	4	1140	1	3	3	2	12	-20	80(day 12)	_	_	_	
83	A	10108352	B/O MK T1	29	Male	33wks+5d	1700	1	1730	1	3	5	4	14	-40	70	_	_	_	
84	A	10108353	B/O MK T2	29	Male	33wks+5d	2200	2	1700	1	2	3	2	14	-50	60	_	_	_	
85	B	10111701	B/O RB	32	Female	33wks+5d	1600	2	2190	1	3	7	6	17	-80	40(day17)	_	_	_	
86	B	10114411	B/O S T1	29	Male	32wks+3d	1600	1	1600	2	4	10	8	17	-60	60	10(day 17)	_	_	
87	B	10114412	B/O S T2	29	Male	32wks+3d	1500	2	1590	2	5	8	6	17	-80	30	20(day 17)	_	_	
88	A	10116535	B/O S	24	Female	33wks+3d	1800	2	1500	2	4	7	5	9	-80	70(day 9)		_	_	
89	A	10119498	B/O G	24	Male	30wks+6d	1760	2	1790	3	6	9	6	22	-30	40	90	20(day22)	_	
90	B	10124366	B/O L	26	Male	32wks+1d	2040	2	1750	3	5	12	9	21	-90	20	10	_	_	
91	B	10122485	B/O S	24	Male	34wks	2000	2	2020	2	3	8	6	20	-70	70	50(day 20)	_	_	
92	A	10064416	B/O SJ	28	Female	32wks+4d	1600	1	2000	1	3	3	2	12	-50	100	_	_	_	
93	B	10022352	B/O AP	30	Male	32wks	1100	1	1580	7	16	21	14	23	-100	100	60	60(day 23)	_	
94	A	10125065	B/O RS	24	Male	34wks	1700	3	1100	1	2	3	2	11	-60	170(day 11)	_	_	_	
95	A	10121015	B/O DS	28	Male	31wks+3d	1060	1	1700	1	8	12	11	25	90	100	100	110(day25)	_	
96	B	10122317	B/O SB	23	Male	31wks+6d	1800	2	1050	2	4	9	7	25	-75	20	80	40(day 25)	_	
97	B	10124581	B/O M	25	Female	32wks+1d	1700	1	1800	2	5	9	7	18	-115	40	20(day 18)	_	_	
98	B	10129005	B/O V	24	Female	33wks+2d	1800	2	1680	3	5	10	7	17	-85	60	30(day 17)	_	_	
								2	1800											