FACTORS PREDICTING ORAL BREASTFEEDING AMONG EARLY AND MODERATE TO LATE PRETERM INFANTS: MULTIPLE GROUP ANALYSIS

YANGNING SHI

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR DOCTOR DEGREE OF PHILOSOPHY
(INTERNATIONAL PROGRAM)
IN NURSING SCIENCE
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YANGNING SHI : FACTORS PREDICTING ORAL BREASTFEEDING AMONG EARLY AND MODERATE TO LATE PRETERM INFANTS: MULTIPLE GROUP ANALYSIS. ADVISORY COMMITTEE: CHINTANA WACHARASIN, Ph.D. PORNPAT HENGUDOMSUB, Ph.D. 2025.

Background：This study examined predictors of oral breastfeeding success among early preterm (28-31 weeks) and moderate-to-late preterm (32-36 weeks) infants in Chinese NICU, framed within Bronfenbrenner's bioecological model. Research Design： A cross-sectional design was implemented with 584 mother-infant dyads recruited from two tertiary hospitals in Yancheng, Jiangsu Province between August 2024 and February 2025. Methods：The study assessed infant factors (feeding readiness, functional status), maternal factors (self-efficacy, milk sufficiency perception, social support), and hospital factors (clinical practices, support policies) using validated measurement tools that were linguistically adapted for Chinese populations. Structural Equation Modeling with multi-group analysis was employed to test gestational age-specific predictive models.

Results：Analyses revealed distinct predictive patterns by gestational age. Among early preterm infants, physiological factors dominated, with feeding readiness (β = 0.17, $p < 0.01$) and functional status (β = 0.23, $p < 0.01$) emerging as significant predictors. For moderate-to-late preterm infants, maternal psychosocial factors showed stronger associations, including self-efficacy (β = 0.27, $p < 0.01$) and social support (β = 0.15, $p < 0.05$), as well as feeding readiness (β = 0.29, $p < 0.01$). Hospital-level factors demonstrated substantial effects across both groups, particularly clinical practices (β = 0.60-0.70, $p < 0.01$) and support policies (β = 0.16-0.24, $p < 0.05$). Both models exhibited excellent fit indices (RMSEA $\leq$ 0.03).

Conclusion and Implications: These findings highlight the need for gestational age-specific breastfeeding interventions in NICUs. For early preterm infants, enhancing neonatal stability and readiness through targeted clinical support is critical. For moderate-to-late preterm infants, maternal self-efficacy and support systems should be prioritized. The

consistent influence of hospital-level factors suggests that standardizing evidence-based breastfeeding practices and policies could substantially improve oral feeding outcomes across all preterm populations. NICU administrators should integrate multi-level strategies to foster a supportive breastfeeding environment tailored to the developmental needs of preterm infants and their families.

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CHAPTER I
INTRODUCTION

Statements and significance of the problems

Breast milk (BM) is a peculiar fluid owing unique properties and resulting the ideal food during early neonatal period (Bardanzellu et al., 2020). Human colostrum, especially the samples belonging to mothers delivering premature newborns, shows high levels of nutrients, cells, and growth-factors specifically sustaining brain maturation, energy production, and intestinal development (Bardanzellu et al., 2020). BM provides optimal infant nutrition, essential immunological and anti-inflammatory benefits. The research shows that different from the composition and nutritional value of full-term breast milk, the biological function of preterm breast milk is more in line with the growth and development characteristics of preterm infants (Boquien, 2018). Among them, the higher protein content and appropriate proportion in preterm breast milk are more conducive to its digestion and absorption. Antimicrobial factors such as leukocytes, secretory IgA and lysozyme, anti-inflammatory factors such as epidermal growth factor and antioxidants not only protect preterm infants from infection, but also promote the development and improvement of immune function of preterm (Bardanzellu et al., 2020). Breast milk contains Docosahexaenoic acid (DHA), which is commonly lacking in premature infants, and plays an important role in the development of the retina and central nervous system of preterm infants (Basak et al., 2020). In addition, breast milk also contains a variety of oligosaccharides that promote the growth of probiotics and inhibit the colonization of pathogenic bacteria, which play the role of prebiotics for premature infants (Nolan et al., 2020). Therefore, breast milk can reduce the incidence of many short-term and long-term complications such as necrotizing enterocolitis, nosocomial infection, retinopathy of preterm infants and feeding intolerance (Adams & Bassler, 2019; Rohsiswatmo, 2021). Breast milk is an irreplaceable food for premature infants. The nutritional and immunological benefits of breast milk are particularly important for very preterm infants born at less than 32 weeks of gestation who are at higher risk of infection and other health and developmental problems than term infants (Bonnet et al., 2019). Due to its advantages, breast milk has reached a consensus and been widely recognized in promoting breast-feeding of premature infants (Lyons et al., 2020). In China, breast milk is also recommended as the preferred food for premature infants (Yang & Lu, 2020). Furthermore, regardless of gestational age or weight, breast milk is the preferred feeding method for premature infants in the NICU as long as there are no medical contraindications (such as severe intestinal malformations, metabolic diseases, etc.) (Cao et al., 2021). For premature infants with stable vital signs (e.g., gestational age ⩾ 34 weeks, birth weight ⩾ 2000 g), it is recommended to start breastfeeding within 1 hour after birth. For extremely low birth weight infants with gestational age < 34 weeks or birth weight < 2000 g, if direct breastfeeding is not possible, breastfeeding should be carried out through a nasogastric tube or dropper, and mothers should be instructed to use a medical breast pump to maintain lactation (Luo et al., 2018).

However, due to the immature development of various organs and systems in premature infants, the reflexes such as sucking are not perfect. In addition, premature infants often need to be transferred to neonatal intensive care unit (NICU) for condition observation and diagnosis and treatment immediately after birth, resulting in the separation of mother and infant, which brings many uncertain factors to the breastfeeding outcome of premature infants in NICU and SNU. Furthermore, although preterm infants have more risk of several health and developmental issues than term infants, they have lower rates of breast milk feeding at discharge and shorter duration as compared with term infants (Bonnet et al., 2019).

Early preterm infants need BM most. Born at 28-31 weeks, they face high risks. Moderate to late preterm infants (32-36 weeks) fare better. Their risks are lower (Bonnet et al., 2019). Yet, breastfeeding varies. Early preterm infants struggle with sucking. Their reflexes are weak (Li et al., 2021). Moderate to late preterm infants improve by 31-34 weeks. They show stronger oral skills and different feeding intolerance.

At present, the breastfeeding rate of premature infants in China still does not reach the ideal breastfeeding rate recommended by the World Health Organization (Huang, 2022). The prevalence of mother’s milk feeding in Chinese NICU is rarely reported. One multi-center investigation conducted in 2012 found that only 2 of 15

(13%) tertiary neonatal care centers in China use breast milk as the source of enteral feeding for preterm infants with birthweight <1500g (Yang & Lu, 2020). Another study conducted in Beijing found that the exclusive breastfeeding rate was as low as 14% at discharge among 723 late preterm infants from 26 hospitals (Zhou et al., 2020). Besides, a study showed that the overall and exclusive breastfeeding rates of 24, 113 premature infants born between May 2015 and April 2018 in 25 Chinese neonatal intensive care units were 58.2% and 18.8%, respectively (Peng et al., 2020). In addition, a survey from 18 tertiary neonatal intensive care units across mainland China, breastfeeding rate for preterm infants at discharge was 65%, with 41% preterm infants being exclusively breastfed during the hospitalization prior to discharge (Yang & Lu, 2020). Furthermore, the duration of breastfeeding is not favourable. 84.5% of premature infants with corrected age of 6-24 months were interrupted (Jing & Zhoujie, 2022). Besides, it provided empirical evidence of the disparity in breastfeeding rates in some studies that: early preterm infants have lower rates (34.5%)（Wang et al., 2020） and 29.6% (Li et al., 2022) compared to moderate-to-late preterm infants 54.8% and 50.2%, respectively.

There are many factors that cause the low rate of breastfeeding in preterm infants in NICU. Breastfeeding is closed related to the mature development of various organs and systems in preterm infants, the reflexes of foraging and sucking are imperfect, which makes unsuccessful breastfeeding for preterm infants can be achieved. Besides, maternal factors also can influence breastfeeding. It plays an important role of maternal behavioral care which means the interactive actions initiated by mothers toward their infants and mothers’ ability to provide the appropriate supply of their own milk to meet their infants’ nutritional addresses their development. In this case, the mother-preterm infant dyad is threatened by the fragility and immaturity of the baby and the unique stress that their mothers experience in the NICU environment (Lau, 2018). The separation of mother and infant refers to the phenomenon that the newborn is sent to the NICU for observation and treatment due to congenital immaturity or disease after birth, resulting in the physical and psychological separation between the mother and the infant, and is also an important factor leading to breastfeeding failure (Jiang & Jiang, 2021).

The infant suck reflex is one of the earliest motor reflexes to develop, emerging in utero around 15 weeks' gestational age and stabilizing around 34 weeks' gestational age (Heller Murray et al., 2021). With a delayed non-nutritive growth/development, an infant's neurophysiologic and neuromotor maturation would likely impact on his/her oral feeding skills and ability to breastfeed safely and competently (Lau, 2018). Breastfeeding in a very preterm infant is challenging, requiring the mother to pump milk regularly until her child has acquired the capacity to suckle at the breast and posing multiple logistic challenges during the long neonatal hospitalization. Consequently, breastfeeding rates for very preterm infants are lower than for full-term infant (Bonnet et al., 2019). Furthermore, the oral motor competence of preterm infants like obvious rooting, efficient areolar grasp, and repeated short sucking bursts were noted from 29 weeks, and occasional long sucking bursts and repeated swallowing from 31 weeks (Li et al., 2021).

In addition, the gestational age of preterm infant can affect breastfeeding outcomes. Studies have shown that the incidence of feeding intolerance in early and late preterm infants is 36.57% and 12.5%, respectively (Jing & Dongsu, 2022). Feeding intolerance problems can have a significant impact on breastfeeding outcomes.

Long-term use of endo-tracheal tube or nasogastric tube for feeding can be the main cause of the later sensory problems in premature infants (Ghomi et al., 2019). All of these factors may limit breast milk intake and jeopardize infant growth and development. Besides, if maternal behavior is inadequate, nurturing and caring/holding one's infant close would affect infant's growth/development. Especially for preterm infants whose non-nutritional growth/development was delayed due to a shortened fetal development or infant postnatal fragility, mother-infant contact would also be reduced along with increased maternal stress, overall leading to a decrease in maternal-infant interaction. In addition, breastfeeding among the late preterm infants mothers was a significantly positive relationship with breastfeeding self -efficacy and social support (He et al., 2022).

Besides, if maternal behavior is inadequate, nurturing and caring/holding one's infant close would affect infant's growth/development. Especially for preterm infants whose non-nutritional growth/development was delayed due to a shortened fetal development or infant postnatal fragility, mother-infant contact would also be reduced along with increased maternal stress, overall leading to a decrease in maternal-infant interaction. In addition, breastfeeding among the late preterm infants mothers was a significantly positive relationship with breastfeeding self-efficacy and social support (He et al., 2022). Breast milk feeding (BMF) involves not only mothers and infants, but also well intentioned family members and friends, as well as health professionals when necessary. Uncontrollable environmental and social factors, such as family obligations and support, lifestyle, maternal characteristics and health, may also exacerbate it (Jiang & Jiang, 2021).

The physical environment of the NICU and the physical and emotional separation of infants from their mothers pose risks to the establishment and maintenance of breastfeeding (Palmquist et al., 2020). Despite recommendations for family centered care, the traditional model of care in NICU situates healthcare professionals as the primary care provider. Then, mothers experienced being marginalized in their infant's NICU care (Palmquist et al., 2020). When draw upon feminist theory in the anthropology of repromduction to examine the fundamental hierarchies of power in neonatal critical care systems that fracture mothers' interrelationships to their newborns, loss of control may lead to exacerbate lactation failure, and engender traumatic postpartum neglect (Palmquist et al., 2020). In this process, emotional support and professional knowledge support for mothers can alleviate their pressure to a great extent and play a positive role in the outcome of breastfeeding (Parker et al., 2018).

Breastfeeding (excluding donated breast milk) can reduce the short-term and long-term morbidity of premature infants in NICU, including feeding intolerance, nosocomial infection, incidence of neonatal necrotizing enterocolitis (NEC), neonatal bronchopulmonary dysplasia (BPD) and retinopathy of prematurity (ROP), physical development and neurocognitive delay, and reduce the rehospitalization rate (Li, 2019). Although the mechanism of breast milk providing the above protective effect is not completely clear, it can be summarized as follows: 1) Breast milk realizes the above protective effect through some bioactive components contained in breast milk but not contained in other dairy products. 2) Through its contained breast milk stem cells, it has an impact on the long-term health changes of preterm infants. 3) The nutrients contained in it are the most suitable for the needs of premature infants to seek a way for its growth and development. Therefore, breastfeeding cannot be replaced by any other feeding method, and breast milk is the best choice for premature infants (Fang et al., 2016). There is no doubt about the protective effect of breast milk on premature infants in NICU, and from an economic point of view.

It can reduce the economic burden. First of all, breast milk is naturally obtained, which greatly reduces the cost compared with other dairy products. In addition, breastfeeding can not only reduce the incidence of early feeding intolerance and various complications of preterm infants, shorten the hospitalization time of preterm infants in NICU (Meier et al., 2017), and reduce the hospitalization expenses. It also has a beneficial impact on the long-term prognosis of premature infants, such as reducing the incidence of endocrine diseases, tumors and allergic diseases in children (Gertosio et al., 2016), resulting in long-term economic benefits. A study in the United

Kingdom shows that increasing the rate of breastfeeding can reduce the incidence of infection in children with NICU in the near future, which is far from enough. It can reduce the incidence of related diseases, thus reducing the expenditure of British medical insurance (Mahon et al., 2016). Another study also showed that breast milk can directly or indirectly reduce the hospitalization expenses of NICU by reducing the incidence rate of delayed sepsis, bronchopulmonary dysplasia, necrotizing enterocolitis, or retinopathy of prematurity, or reducing the severity of the disease. Therefore, promoting breastfeeding can not only reduce the economic burden of families, but also have a beneficial impact on social and economic development.

There was dramatic variation in breastfeeding rates among the preterm infants in NICU in China. It revealed that there are significant inconsistencies in the practice of breastfeeding preterm infants among the investigated NICU. The findings could be partially explained by a lack of authoritative and uniform guidelines to regulate and guide health professionals to deal with the specific problems of breastfeeding preterm infants. There were multiple standards used in NICU due to the lack of uniform guidance, health-care providers often combine multiple standards with clinical experience to determine the final treatment, which will lead to various clinical practices and different solutions for the specific clinical circumstances (Peng et al., 2020).

Promotion of oral breastfeeding is now recognized as a collective responsibility (Organization, 2020). In term infants, a multidimensional approach including a mixture of interventions involving the health system and the community environment seems a key strategy to protect, promote, and support optimal breast milk feeding (BMF) practices (Rollins et al., 2016; Sinha et al., 2015). Preterm infants are hospitalized in neonatal units, and interventions at this level potentially have high impact on BMF at discharge (Mitha et al., 2019). The quality of breastfeeding and its influencing factors in preterm infants after discharge has been explored in some, which included mother's factors and preterm infants' factors. It just mentioned mother's factor that can influence the breastfeeding condition in a study (Wang et al., 2019). In addition, there is a paucity of literature in China that examines factors associated with breastfeeding outcomes in early preterm and mid-to late-term preterm infants.

Breastfeeding is universally acknowledged as the optimal nutritional source for preterm infants, offering unparalleled immunological, nutritional, and developmental benefits (Bardanzellu et al., 2020). However, preterm infants, particularly those in neonatal intensive care units (NICU), face significant barriers to achieving successful oral breastfeeding due to their physiological immaturity and the complexities of the NICU environment. In China, despite the recognized advantages of breast milk, breastfeeding rates among preterm infants remain sub-optimal, with exclusive breastfeeding at discharge ranging from 14% to 41% across various studies (Peng et al., 2020; Zhou et al., 2020). This discrepancy underscores the urgent need to systematically explore the factors influencing breastfeeding outcomes to support the development of evidence-based interventions. Currently, guidelines employed by Chinese NICU managers predominantly rely on expert consensus rather than robust empirical evidence, highlighting a critical gap in the availability of targeted, evidence-based protocols tailored to Chinese unique healthcare context (Peng et al., 2020).

A significant limitation in the existing literature is the paucity of knowledge regarding how breastfeeding predictors differ across gestational age subgroups, specifically early preterm infants (28-31 weeks) and moderate to late preterm infants (32-36 weeks). While substantial research has established the general benefits of breast milk for preterm infants (Souza et al., 2024), most studies aggregate preterm infants into a single category or focus narrowly on very low birth weight infants, neglecting the heterogeneity within this population (Peng et al., 2020). Recent studies provide insight into the breastfeeding rates for premature infants in China, with a clear differentiation by gestational age. A study by Wang et al. (2020) reported that at discharge from neonatal intensive care units (NICU), 54.8% of mid-to-late premature infants (32-36 weeks) were breastfed, compared to 34.5% of early premature infants (28-31 weeks) (Wang et al., 2020). This study underscores the significant gap in breastfeeding success between the two groups. Another study by Li et al. (2022) corroborated these findings, reporting breastfeeding rates of 50.2% for mid-to-late premature infants and 29.6% for early premature infants at discharge (Li et al., 2022).

According to existing researches, there are many reasons for this difference. For instance, early preterm infants exhibit greater physiological instability, including weaker sucking reflexes and higher rates of feeding intolerance (36.57% vs. 12.5% in moderate to late preterm infants), which complicates breastfeeding initiation (Jing et al., 2022; Pados et al., 2021). In contrast, moderate to late preterm infants demonstrate more advanced oral feeding skills by 32-34 weeks, suggesting distinct developmental trajectories that may influence breastfeeding success differently (Anuk Ince et al., 2024).

Early preterm infants, born at 28-31 weeks, face heightened risks of complications such as respiratory distress and neuromuscular immaturity, which significantly hinder their ability to coordinate sucking, swallowing, and breathing—key prerequisites for oral breastfeeding (Guan et al., 2023). Conversely, moderate to late preterm infants (32-36 weeks) exhibit greater physiological stability and feeding competence, neuromuscular development is relatively mature (Pados et al., 2021). Besides, early preterm infants has immature coordination, high energy demands, autonomic issues, while moderate-to-late preterm infants has better coordination, improved feeding efficiency (Martini,et al., 2023). In addition, in NICU, early preterm infants mainly face challenges of respiratory distress, fatigue, and clinical dependency, while moderate to late preterm infants mainly face sensory issues from tubes and transitioning to oral feeding (Li et al., 2024).

Due to the lack of subgroup-specific analysis obscures the differential impacts of infant, maternal, and hospital factors, impeding the design of precision interventions that address the unique needs of each group. Therefore, it is necessary to separate early and moderate to late preterm infants to examine these groups independently is essential to delineate whether the same predictors (e.g., infant readiness, maternal confidence, or hospital support) exert uniform or varying effects across gestational ages. Such differentiation is critical in a Chinese context, where no studies have analyzed predictive factors for early preterm infants and moderate to late preterm infants and resource allocation and clinical practices vary widely, and uniform approaches may fail to address the specific challenges faced by each subgroup (Deng et al., 2021).

Conducting a multiple group analysis offers several compelling benefits. First, it facilitates the identification of both shared and unique predictors of breastfeeding success across early and moderate to late preterm infants, enabling the development of comprehensive yet tailored evidence-based guidelines. For example, while hospital-based interventions like kangaroo mother care may universally enhance breastfeeding initiation, their impact may be more pronounced in early preterm infants who rely heavily on such support to overcome developmental deficits (Akinbami, 2024). Furthermore, this approach allows for the statistical examination of invariance-determining whether the relationships between predictors and breastfeeding outcomes are consistent or diverge across groups-thus providing insights into the generalizability or specificity of interventions (Pados et al., 2021). Moreover, by elucidating group-specific needs, multiple group analysis can optimize resource allocation in NICU, ensuring that interventions are both effective and efficient. Ultimately, these benefits contribute to improved breastfeeding rates, reduced morbidity, and enhanced long-term health outcomes for preterm infants, aligning with global health priorities (Jiang et al., 2024).

In light of these considerations, this study addressed the pressing need for national evidence-based guidelines tailored to Chinese national conditions. The absence of such guidelines has led to inconsistent clinical practices and sub-optimal breastfeeding outcomes in Chinese NICU (Peng et al., 2020). This research aimed to examine the predictive factors of oral breastfeeding among early preterm (28-31 weeks) and moderate to late preterm (32-36 weeks) infants in Yancheng, focusing on infant factors (e.g., readiness oral feeding behavior, functional status), maternal factors (e.g., breastfeeding self-efficacy, breast milk sufficiency), and hospital factors (e.g., breastfeeding practices in NICU, breastfeeding support in NICU). By elucidating these predictors during the early days of life, the findings would provide a theoretical foundation for the early initiation of breastfeeding, inform the development of standardized clinical protocols, and offer empirical evidence to guide future interventions. The potential impact of this study lied in its capacity to enhance breastfeeding rates among preterm infants in China, reduce healthcare disparities and contribute to the global knowledge base on neonatal care.

Research objectives

To examine factors influencing oral breastfeeding comparing between early preterm (28-31 weeks) and moderate-to-late preterm (33-36 weeks) subgroups in NICU.

Hypotheses

1. Readiness for oral feeding behavior will have a stronger positive association with successful oral breastfeeding in early preterm infants (28-31 weeks) compared to moderate-to-late preterm infants (32-36 weeks).

2. Functional status will be a more critical predictor of oral breastfeeding success in early preterm infants due to their physiological immaturity.

3. Breastfeeding self-efficacy will demonstrate a stronger positive association with oral breastfeeding outcomes in moderate-to-late preterm infants, as maternal confidence is more influential when infants exhibit advanced feeding readiness.

4. Social support will significantly mediate breastfeeding success in moderate-to-late preterm infants, whereas breast milk sufficiency will play a more pronounced role in early preterm infants due to higher clinical dependency.

5. Breastfeeding practices will have a greater impact on oral breastfeeding outcomes in early preterm infants;

6.Breastfeeding support policies will be more critical for moderate-to-late preterm infants during transition to oral feeding.

Conceptual framework

The conceptual framework of this study was guided by Bronfenbrenner's bioecological model (Bronfenbrenner, 2005), an evolved theoretical system that builds upon his earlier ecological systems theory. This model emphasizes the dynamic interplay between individuals and their nested environmental systems (micro-, meso-, exo-, macro-, and chronosystems), with a focus on proximal processes as primary mechanisms of development. The bioecological model , along with its corresponding research designs, provides a comprehensive lens for studying human development over time.

The bioecological model addresses two closely related but fundamentally different developmental processes, each taking place over time. The first process defines the phenomenon under investigation continuity and change in the biopsychological characteristics of human beings. The second focuses on the development of the scientific tools theoretical models and corresponding research designs required for assessing continuity and change. These two tasks cannot be carried out independently, for they are the joint product of emerging and converging ideas, based on both theoretical and empirical grounds a process called developmental science in the discovery mode (Bronfenbrenner & Evans, 2000).

Meanwhile, it consists of four subsystems: microsystem (referring to the direct environment for individual activities and communication, which is constantly changing and developing, and is the innermost layer of the environmental system), mesosystem (referring to the connection or relationship between various micro systems), exosystem (referring to the system that children do not directly participate in but have an impact on their development), macrosystem (referring to the cultural, subculture and social environment existing in the above three systems). Bronfenbrenner's model also includes a chronosystem, or diachronic system. Take time as a reference system to study the psychological changes in individual growth. He emphasized the change or development of children, and combined time and environment to investigate the dynamic process of children's development. With the passage of time, the micro system environment of children's survival is constantly changing. Bronfenbrenner calls this environmental change "ecological transformation", and each transformation is a stage of individual life development.

In this study, the biopsychological characteristics of preterm infant such as functional status, oral feeding skills are in the process of development, while the factors of mothers such as efficacy of breastfeeding infants and the effect hospitals policy to breastfeeding also continued improving. All of these developments can impact the outcome of breastfeeding in preterm infant. The predict factors which may affect the outcome of oral breastfeeding include:

The infants' factors include Readiness Oral Feeding Behavior (infants ' coordinated sucking-swallowing-breathing patterns, alertness during feeding, and non-nutritive sucking competence), Function status, which were considered as microsystem. All of these factors have positive correlation with the outcome of oral breastfeeding.

The mother factors include Breastfeeding self-efficacy Dennis (the confidence of pregnant women in self-evaluation of their ability to breastfeed their infants), Breast milk sufficiency, Social support, which were considered to be mesosystem. All of these factors have positive correlation with the outcome of oral breastfeeding.

The hospital factors include Breastfeeding practice (Breastfeeding advocacy, Knowledge about breastfeeding, Collection and transport of breast milk, Screening and acceptance of breast milk of breast milk) and Breastfeeding support (breastfeeding policy in NICU), which were considered as exosystem. Effective breastfeeding health education, breastfeeding policy and oral breastfeeding stimulation have positive correlation with the outcome of oral breastfeeding.

The Ecological systems theory was aligned with the hypotheses and research questions for this study. Preterm infants who were breastfed were compared to those who were not breastfed.

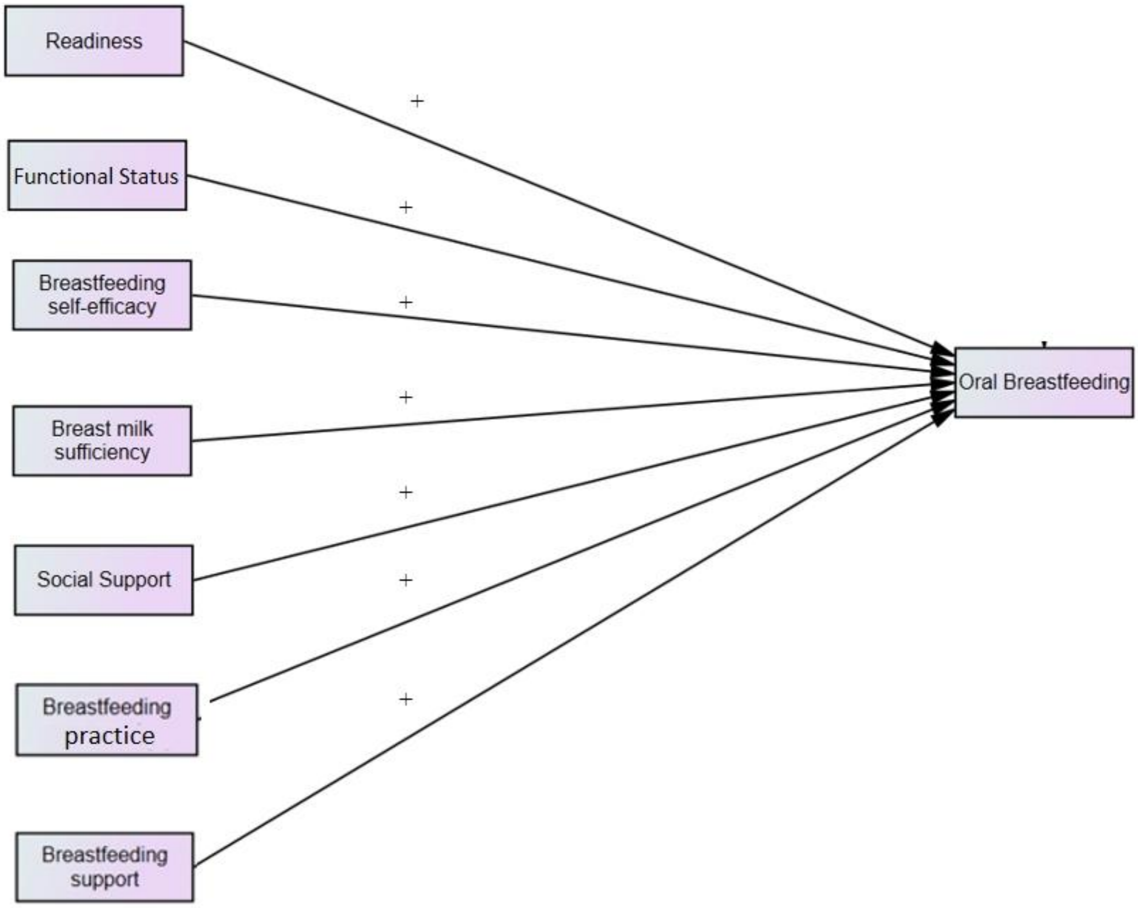

Figure 1 The hypothesized model of factors which predicts oral breastfeeding in early and moderate to late preterm infants

Scope of the research

An empirical of a multi-group analysis was conducted to investigate the influence of ten predictors on oral breastfeeding. The participants of this study was the preterm infants in NICU OR SICK NEWBORN UNIT and their parents who lives in Yancheng from August 2024 -February 2025.

Definition of terms

Oral Breastfeeding refers to the process of premature infants directly receiving mother's breast milk through oral sucking, emphasizing the infant's physiological readiness (such as sucking-swallowing-breathing coordination ability) and the multi-level support of the mother and the medical environment. Its core is to promote the transition of premature infants from tube feeding to independent feeding, while ensuring nutritional intake and neurological development. In this study, this concept It was measured by the Preterm Infant Breast-feeding Behavior Scale (PIBBS) , covering behavioral indicators such as foraging reflexes, feeding posture, and sucking frequency (Nyqvist et al., 1996), which was translated to Chinese version (Xiurong, 2012).

Gestational age (GA) refers to time from the first day of the last normal menstruation to delivery, which GAin 28-31 weeks is early preterm infants and GAin 32-36 weeks is moderate to late preterm infants. The data was collected in the demographic questionnaire of preterm infants.

Functional status refers to health and development in preterm infants over time from birth until discharge from the NICU. It contains 8 Key infant factors reflective of functional status: respiratory support, oxygen administration, apnea, bradycardia, desaturation, thermoregulation, feeding, and weight gain, each scored with three to six gradations It was measured by the Premature Infant Index (PREMIITM) (R. M. Ward et al., 2022).

Readiness oral feeding behavior behavior refers to the physiological and behavioral ability of premature infants to safely and effectively perform oral feeding, and is a key indicator for determining whether they can transition from tube feeding to autonomous sucking. Its core elements include: physiological maturity: Corrected Gestational Age (CGA), breathing-sucking-swallowing coordination, oral reflexes (such as rooting reflex, sucking reflex); behavioral state: regularity of arousal cycle, non-nutritive sucking ability, head control and rooting movements (such as opening the mouth, turning the head to find the nipple); environmental adaptability: response to feeding stimuli (such as nipple touch) and stress tolerance (such as blood oxygen stability during feeding). In this study, "Readiness Oral Feeding Behavior" was defined as the state of readiness that the preterm infant needs to have at the beginning of breastfeeding, including behaviors such as "seeking the nipple, opening the mouth, and extending the head forward to touch the nipple".

The Premature Infant readiness oral feeding behavior Assessment Scale (Fujinaga, 2007) was used for quantitative assessment. It includes 18 indicators, covering dimensions such as corrected gestational age, behavior, oral morphology, and reflexes, which was translated to Chinese version (Xiurong, 2012).

Breastfeeding self-efficacy refers to the mother's confidence and belief in her ability to successfully implement and maintain breastfeeding. Its theoretical roots are based on Bandura's self-efficacy theory (Bandura, 1977), which emphasizes that an individual's belief in completing a specific task directly affects his or her behavioral choices, effort level, and persistence. In the context of premature infant feeding, BSE specifically refers to the mother's assessment of her own coping ability when facing feeding challenges (such as weak sucking power and insufficient milk secretion of premature infants). It was measured by Breastfeeding Self-Efficacy Scale (BSES) (Dennis, 2003), which was translated to Chinese version (Huiru, 2013).

Breast milk sufficiency refers to the ability of the breast milk to meet the infant's nutritional needs in terms of quantity and quality, covering two levels: 1) Physiological adequacy: assessed through objective indicators such as milk production (ml/day), infant weight gain (g/day), and urine output (⩾6 times/day); 2) Subjective perception of adequacy: the mother's confidence and judgment on whether the milk is sufficient, which is often affected by culture, experience, and psychological state (McCarter-Spaulding & Kearney, 2001). This study refers to the mother's subjective perception of the adequacy of breast milk, measured by the Perception of Insufficient Milk (PIM) (McCarter-Spaulding & Kearney, 2001), which was translated to Chinese version (Wu & Wacharasin, 2022).

Social support refers to the emotional, informational and material resources that individuals obtain through social networks (such as family, friends, medical staff, and community) to cope with stress or achieve goals. In the context of breastfeeding, its core dimensions include: emotional support: encouragement and empathy from family or peers to reduce the mother's anxiety and loneliness; information support: breastfeeding knowledge and skill guidance provided by medical staff (such as correct breastfeeding posture); instrumental support: practical help (such as taking care of the baby and sharing housework) to enable the mother to focus on breastfeeding; evaluation support: positive feedback from the outside world on the mother's breastfeeding behavior to enhance her sense of self-worth (Cohen, 1985). It was measured by Multidimensional Scale of Perceived Social Support Item and Subscale (Zimet et al., 1988), which was translated to Chinese version (Wagg, 2020).

Breastfeeding practice in NICU refers to systematic measures taken by medical institutions or medical staff to promote breastfeeding, covering multi-dimensional actions such as health education, skill guidance. Its core goal is to improve maternal and infant feeding ability and reduce dependence on formula milk. In this study it referred to breastfeeding advocacy, instruction in the collection and transport of breast milk, Screening and acceptance of breast milk of breast milk that NICU provides for the parents ' infants in order to promote successful, safe and sustained oral breastfeeding. It was measured by Breastfeeding practice in NICU questionnaire which was created by the researcher.

Breastfeeding support in NICU refers to a series of policies NICU implements to promote breastfeeding mainly about letting parents involve in early feeding support. It can be measured by NICU breastfeeding support questionnaire which was created by the researcher. It contained the length of stay per visit of the parents, whether parents could stay during medical rounds and could spend the night in unit etc.

CHAPTER 2
LITERATURE REVIEW

This chapter presents literature reviews emphasizing the relevant literature that provides more information and empirical bases for the hypothesized model of the study. Literature reviews are organized into four parts. The first part is an overview of preterm infants. The second part addresses the Oral Breastfeeding among preterm infants in NICU including definition, cause, and impact of oral breastfeeding among preterm infants. The third part is the theoretical foundation for the study. The fourth part presents the hypothesized model of oral breastfeeding among preterm infants in NICU. The fourth part presents factors related to oral breastfeeding among preterm infants in NICU.

Overview of Preterm infants

Preterm birth, defined as the delivery of an infant prior to 37 completed weeks of gestation, is the leading cause of neonatal mortality. Early preterm infants are defined as those with a gestational age between 28 and 32 weeks (28 ≤ GA <32 weeks); moderately and late preterm infants are defined as those with a gestational age between 32 and 37 weeks (32 ≤ GA <37 weeks) (WHO, 2012).Worldwide, about 15 million preterm babies are born annually (Karnati et al., 2020). Globally, one in ten babies are born preterm, and the preterm birth rate has been increasing. The second highest number of preterm births are reported in China, with more than 1 million babies born preterm every year (Zhang et al., 2021). The data suggested that the increasing preterm birth rate might have accelerated after the introduction of the universal two child policy in China. Very preterm births (born between 28 and 31 weeks gestation) showed the highest increase, followed by late preterm births (born between 34 and 36 weeks gestation) (Deng et al., 2021). In China, the large number of annual preterm births combined with a rising trend is a cause for concern.

Meanwhile, preterm infants are at increased risk for morbidities involving nearly every organ system such as neonatal respiratory distress syndrome, asphyxia, pulmonary infection, nervous system hypoplasia and so on as well as higher risk of mortality when compared to term neonates (Karnati et al., 2020). Preterm infants face elevated risks. Early preterm infants suffer most. Mortality rates reach 15.8% for very preterm births (Feng et al., 2021). Respiratory distress and infections are common. Moderate to late preterm infants fare better. Their mortality rate is 1.5-3.7% (Feng et al., 2021). Yet, morbidities persist. Neurodevelopmental delays are a concern (Cheong et al., 2017). China's increasing preterm rates demand attention. Regional variations complicate care. Rural areas lag behind urban centers (Deng et al., 2021).

Oral Breastfeeding among preterm infants in NICU

Adequate nutrition stands as a cornerstone for the optimal growth and development of preterm infants, aiming to replicate the intrauterine nutritional profile (Embleton et al., 2019). Preterm infants require enhanced nutrient intake to compensate for their abbreviated gestation. Insufficient nutritional support during this critical period has been strongly linked to adverse outcomes, including impaired neurodevelopment and stunted physical growth (Embleton et al., 2019). Research consistently demonstrates that deficits in key nutrients, particularly proteins and long-chain polyunsaturated fatty acids such as docosahexaenoic acid (DHA), compromise brain development and increase susceptibility to morbidities (Ziegler, 2019). Addressing these nutritional needs promptly is paramount to mitigating long-term health consequences.

The initiation of early feeding plays a pivotal role in shaping the health trajectory of preterm infants, particularly in the immediate postnatal period (Embleton et al., 2019). Delays in establishing enteral nutrition exacerbate nutrient deficits, leading to compromised growth and increased morbidity risks, with the brain being especially vulnerable to such interruptions (Miller et al., 2018). Benefits of early feeding extend beyond immediate survival, fostering physiological stability and supporting long-term developmental outcomes (Ziegler, 2019).

In China, although national guidelines recommend breast milk as the best source of nutrition for preterm infants, the exclusive breastfeeding rate at discharge remains suboptimal (14-41%) compared with global benchmarks (Peng et al., 2020; Zhou et al., 2020). The breastfeeding rate of early preterm infants (<32 weeks) is too low (29.6-34.5 %) due to physiological instability and maternal-infant separation (Li et al., 2022).

According to some studies, possible reasons include: prolonged NICU stay and restrictions on parental visits increase maternal anxiety and reduce breastfeeding persistence (Jiang & Jiang, 2021); traditional beliefs that increasing infant weight by supplementing with formula often conflict with medical advice (Yang & Lu, 2020). In addition, only 13% of level 3 NICUs routinely use breast milk for infants weighing <1500 g, reflecting inconsistent implementation of international standards (Yang & Lu, 2020). Meanwhile, the lack of standardized kangaroo mother care (KMC) and lactation support guidelines has led to fragmented practices (Peng et al., 2020).

Breast milk is the best food for premature infants. It suggested that there is no food more conducive to preterm infants (Wang Li, 2023). Different from the composition and nutritional value of full-term breast milk, the biological function of preterm breast milk is more in line with the growth and development characteristics of preterm infants (Boquien, 2018). In a meta-analysis of 41 observational studies, protein and fat content was higher in breast milk of preterm infants compared with full-term newborns during the first 10-12 weeks of lactation. In addition, Of the only six studies with data of free amino acids from preterm milk (average 12.5 postpartum days), total amino acids and total nitrogen levels were higher in preterm milk, with a significantly greater content in valine, threonine, and arginine, with the exception of glutamine, which was significantly lower by nearly one-half in preterm than term human milk. Therefore, preterm milk is a more appropriate source of protein and certain amino acids than term milk to accommodate for the rapid growth rates of premature infants. (Sánchez Luna et al., 2021). Furthermore, breast milk can reduce the incidence of infection and many short-term and long-term complications such as necrotizing enterocolitis, nosocomial infection, retinopathy of preterm infants and feeding intolerance (Peng et al., 2020). Because of its incomparable advantages, breast milk has become a consensus to promote breast-feeding of preterm infants, which has been widely recognized. The American Association of family doctors, the society of Pediatrics, and the European Society of pediatric nutrition strongly recommend breast-feeding for preterm infants (Lapillonne et al., 2019). China also proposes to recommend breast milk as the first choice for premature infants (Peng et al., 2020).

Early administration of breast milk has garnered extensive evidence for its protective effects, reducing infection rates and shortening hospital stays, as demonstrated in systematic reviews cited over 150 times (Miller et al., 2018).

However, over the past two decades, the challenge of feeding preterm infants remains in China (Meiyin, 2017).

Oral Breastfeeding refers to feed infants at breast (Organization, 2020). It refers to feeding a preterm infant at his/her mother's breast in this study, which would be measured by Preterm Infant Breast-feeding Behavior Scale (PIBBS) (Xiurong, 2012). Breastfeeding is related to the mature development of various organs and systems in preterm infants, which related to gestational age of infants. The reflexes of foraging and sucking are perfect, which makes successful breastfeeding for preterm infants can be achieved. The mature development involves sucking ability, swallowing ability, and the respiratory process development.

Recent studies provide insight into the breastfeeding rates for premature infants in China, with a clear differentiation by gestational age. A study by Wang et al. (2020) reported that at discharge from neonatal intensive care units (NICU), 54.8% of mid-to-late premature infants (32-36 weeks) were breastfed, compared to 34.5% of early premature infants (28-31 weeks) (Wang et al., 2020). This study underscores the significant gap in breastfeeding success between the two groups. Another study by Li et al. (2022) corroborated these findings, reporting breastfeeding rates of 50.2% for mid-to-late premature infants and 29.6% for early premature infants at discharge (Li et al., 2022). This study further supports the trend that mid-to-late premature infants have higher breastfeeding rates, likely due to their relatively advanced physiological development, including better sucking and swallowing coordination.

Preterm infants encounter significant barriers to oral breastfeeding due to the incomplete maturation of critical physiological systems (Walsh et al., 2019). Preterm infants encounter significant barriers to oral breastfeeding due to the incomplete maturation of critical physiological systems (Walsh et al., 2019). The sucking reflex, which begins developing in utero around 15 weeks and typically stabilizes by 34 weeks, is disrupted by preterm birth, resulting in poor coordination and endurance (Hafström et al., 2019). This developmental lag, combined with weak neuromuscular control, impedes the ability to sustain effective oral feeding (Pados et al., 2021). Additionally, prolonged use of nasogastric or endotracheal tubes in neonatal intensive care units (NICU) introduces sensory complications that further hinder feeding progression (Pados et al., 2021). The mechanisms governing oral breastfeeding differ markedly across preterm gestational age groups, driven by distinct developmental trajectories and pathological profiles (Pados et al., 2021). For early preterm infants (28 -32 weeks), sucking behavior emerges around 29 weeks but remains characterized by short, inefficient bursts due to limited neuromuscular coordination (Hafström et al., 2019). Swallowing function, appearing inconsistently by 31 weeks, is further hampered by inadequate respiratory control, leading to frequent fatigue and feeding interruptions (Walsh et al., 2019). The underlying pathology reflects a profound immaturity of the central nervous system, exacerbating these limitations (Pados et al., 2021). In contrast, moderate to late preterm infants (32-36 weeks) exhibit more advanced oral feeding capabilities, with sustained sucking bursts developing by 32-34 weeks and swallowing stabilizing thereafter (Hafström et al., 2019). The pathology in this group is less severe, with improved respiratory stability and neuromuscular coordination allowing for greater feeding efficiency (Walsh et al., 2019). These differences are substantiated by longitudinal studies tracking feeding milestones, underscoring the gradual maturation of oral motor skills as gestational age increases (Pados et al., 2021). Distinct differences in oral breastfeeding capacity emerge between early preterm (28-31 weeks) and moderate to late preterm (32-36 weeks) infants, reflecting variations in developmental readiness and clinical outcomes (Pados et al., 2021). Feeding intolerance affects 36.57% of early preterm infants, a rate markedly higher than the 12.5% observed in moderate to late preterm infants (Feng et al., 2021).

Maternal factors also can influence breastfeeding. Premature infants often need to be immediately transferred to the neonatal intensive care unit or sick newborn unit for condition observation and diagnosis and treatment after birth, resulting in the separation of mother and infant (Mawson & Xueyuan, 2013). In this case, the mother-preterm infant dyad is threatened by the fragility and immaturity of the baby and the unique stress that their mothers experience in the NICU environment (Lau et al., 2007). Pregnant women need artificial or electric sucking for several days or even months to start and maintain lactation, insufficient lactation is an important related factor leading to the low breastfeeding rate of premature infants after discharge (Mawson & Xueyuan, 2013). Additionally, Maternal stress and limited access to breastfeeding support compound these difficulties of oral breastfeeding, particularly in resource-variable settings across China (Chen et al., 2022). Maternal factors exert a substantial influence on oral breastfeeding outcomes, with breastfeeding self-efficacy emerging as a key determinant, particularly for moderate to late preterm infants (Dennis et al., 2020). For early preterm infants, maternal stress and limited access to support often overshadow self-efficacy, necessitating greater reliance on hospital-based interventions (Deng et al., 2021).

In addition, reinforcing parental presence in the NICU may influence breastfeeding in preterm infants. NICU exacerbate these challenges, with mother-infant separation in NICU disrupting bonding and lactation initiation (Deng et al., 2021). Programs aimed at supporting parental presence and interaction with their infants in NICU have been shown to reduce Reinforcing parental presence in the neonatal intensive care unit may be one such factor (Cuttini et al., 2019). Programs aimed at supporting parental presence and interaction with their infants in NICU have been shown to reduce morbidity (Lester et al., 2014; Ortenstrand et al., 2010), infant stress and pain (Lester et al., 2014) and length of hospital stay (Melnyk et al., 2006; Ortenstrand et al., 2010) and to improve early neuro-behavior (Lester et al., 2014; Reynolds et al., 2013) infant growth (Lester et al., 2014; O'Brien et al., 2013) language and cognitive skills at follow-up (Caskey et al., 2014; Vohr et al., 2017). However, reports on the relation with breastfeeding are scarce. An Italian study carried out in five NICU (Vohr et al., 2017) found that a policy of free 'around the clock' parental visiting was associated with increased frequency of breast milk feeding in very low birth weight singletons at 4 weeks of life (58% vs 16%), while another pilot study in Canada reported increased breastfeeding in infants assigned to a care by parent program (Gómez-Cantarino et al., 2020). Similarly, the higher breastfeeding rates documented at discharge among infants cared for in a single-family room unit were attributed to the increased opportunity for maternal- infant interaction and kangaroo care (KC) compared with usual open-ward care (Domanico et al., 2011). Hospital practices, including structured lactation support and family-integrated care, significantly enhance breastfeeding success across both groups, with evidence-based protocols demonstrating improved initiation rates (Nyqvist et al., 2013). The disparities of developmental readiness and clinical outcomes between early prterm infants and moderate to late preterm infants translate into differing clinical needs, with early preterm infants requiring more intensive NICU support due to prolonged stays and greater physiological instability (Deng et al., 2021). Moderate to late preterm infants, benefiting from shorter hospital durations and enhanced maternal self-efficacy, exhibit a stronger capacity to transition to oral breastfeeding (Pados et al., 2021). In China, the absence of standardized, evidence-based guidelines hampers these efforts, with neonatal units relying heavily on expert consensus rather than empirical data (Chen et al., 2022). This gap underscores the need for tailored interventions that address the unique challenges faced by early and moderate to late preterm infants, a focus central to this dissertation (Deng et al., 2021).

Impact of breastfeeding among preterm infants

Breastfeeding is universally recognized as the optimal nutritional form for all infants, with benefits extending far beyond basic nutrition. Preterm breast milk exhibits a distinct biochemical profile tailored to meet the accelerated developmental needs of premature infants. Compared to term milk, preterm milk contains: It has elevated levels of protein, particularly immunoglobulins, which are crucial for enhancing the immune system of vulnerable preterm infants. Additionally, it is richer in certain fatty acids that promote brain development, making it an essential resource for their growth and overall health. protein content (1.8-2.4 g/dl vs. 1.1-1.3 g/dl in term milk), which is critical for supporting rapid somatic growth and neurodevelopment (Boquien, 2018; Underwood, 2022). It contains high concentrations of bioactive amino acids, including valine (+28%), threonine (+19%), and arginine (+15%), which enhance nitrogen retention and intestinal maturation (Sánchez Luna et al., 2021). Its lipid profiles are optimized, with docosahexaenoic acid (DHA) at 0.3-0.5% of total fatty acids to support retinal and neural development and elevated medium-chain triglycerides (MCTs) for effective energy utilization (Basak et al., 2020; Lapillonne et al., 2023). The immunological composition of preterm milk is equally remarkable. Secretory IgA (sIgA) levels of preterm breast milk reach 2-3 g/L, providing mucosal immunity against enteric pathogens (Bardanzellu et al., 2020). Lysozyme concentrations (300-400 μg/mL) are 30% higher than in term milk, enhancing bacteriolytic activity (Trend et al., 2021). The epidermal growth factor inside is 200-400 ng/ml, promoting intestinal epithelial repair, while lactoferrin (1.5-4.0 g/L) reduces oxidative stress via iron chelation (Gila-Diaz et al., 2020).

In short-term clinical benefits, it can reduce necrotizing enterocolitis . A 2023 meta-analysis of 18 RCTs (n=5,632 preterm infants) demonstrated that exclusive human milk feeding reduces NEC incidence by 58% (RR=0.42, 95% CI: 0.34-0.52) compared to formula (Sullivan et al., 2023). This protective effect is attributed to human milk oligosaccharides. Fucosyllactose (2'FL) and 3'-sialyllactose (3'SL) inhibit pathogen adhesion while promoting Bifidobacterium colonization (Bering, 2023). Furthermore, preterm milk can lower nosocomial infection rates. It reduces late-onset sepsis risk by 35% (OR=0.65, 95% CI: 0.52-0.81), as shown in a multi-center cohort study (n=2, 189 infants <32 weeks GA) (Patel et al., 2021). It makes leuko cyte recruitment more efficient, enhancing the immune response in vulnerable neonates. This immune modulation is crucial for preterm infants, who are often at a higher risk for infections due to their underdeveloped immune systems.cyte-mediated immunity, which has breast milk macrophages phagocytose Staphylococcus epidermidis (a common NICU pathogen) in vitro (Trend et al., 2021). It can also make actoferrin’s bacteriostatic effects, which can deprive gram-negative bacteria of iron, inhibiting biofilm formation (Gila-Diaz et al., 2020). A 2022 prospective study (n=487 infants <30 weeks GA) revealed that ⩾50% human milk intake decreases severe Mitigation of Retinopathy of Prematurity (Stage 3+) by 42% (aOR=0.58, 95% CI: 0.39-0.85) (Hellström et al., 2022).

Preterm breast milk can also reduce the economic burden. First of all, breast milk is naturally obtained, which greatly reduces the cost compared with other dairy products. In addition, breastfeeding can not only reduce the incidence of early feeding intolerance and various complications of preterm infants, shorten the hospitalization time of preterm infants in NICU(Lau et al., 2007), and reduce the hospitalization expenses. It also has a beneficial impact on the long-term prognosis of premature infants, such as reducing the incidence of endocrine diseases, tumors and allergic diseases in children (Gertosio et al., 2016), resulting in long-term economic benefits. A study in the UK shows that increasing the rate of breastfeeding can reduce the incidence of infection in children with NICU in the near future, which is far from enough. It can reduce the incidence of related diseases, thus reducing the expenditure of British medical insurance (Mahon et al., 2016). Another study also showed that breast milk can directly or indirectly reduce the hospitalization expenses of preterm infants by reducing the incidence rate of delayed sepsis, bronchopulmonary dysplasia, necrotizing enterocolitis, or retinopathy of prematurity, or reducing the severity of the disease. Therefore, promoting breastfeeding can not only reduce the economic burden of families, but also have a beneficial impact on social and economic development. Therefore, breastfeeding cannot be replaced by any other feeding method, and breast milk is the best choice for premature infants (Meier et al., 2010).

The theoretical foundation for the study

The determination of factors influencing oral breastfeeding in preterm infants is complex and multifaceted. Gaining a comprehensive understanding of these factors can provide a valuable framework to improve oral breastfeeding in preterm infants. Bronfenbrenner’s bioecological model (Bronfenbrenner, 2005) was used as a conceptual framework in this study.

Bronfenbrenner’s Ecological Systems Theory (EST), first articulated in its mature form in Bronfenbrenner (2005), posits that human development is shaped by a series of nested environmental systems that interact dynamically to influence individual outcomes. This theory is particularly apt for the study of oral breastfeeding in preterm infants, given the multifaceted nature of the factors involved, including infant physiology, maternal psychosocial attributes, and institutional practices. The theory comprises five key systems: Microsystem: The immediate environment where the individual has direct interactions. In this study, infant factors like readiness for oral feeding and functional status are categorized here, reflecting the infant’s physiological and neurodevelopmental capacities critical for breastfeeding success; Mesosystem: The interconnections between different microsystems, such as the relationship between the mother’s breastfeeding self-efficacy and the infant’s feeding behaviors, or the linkage between family dynamics and hospital support structures. Maternal factors, including breastfeeding self-efficacy, perceived breast milk sufficiency, and social support, are analyzed at this level, highlighting their role in facilitating breastfeeding outcomes; Exosystem: External settings that indirectly affect the individual, such as hospital breastfeeding policies and practices, which shape the caregiving environment without the infant ’ s direct participation. Hospital factors like breastfeeding practice and support, such as lactation counseling and family-integrated care models, are examined here for their indirect influence on breastfeeding success; Macrosystem: The broader sociocultural context, including healthcare policies and cultural attitudes toward breastfeeding, which frame the operational norms of the inner systems. While less explicitly detailed in the study, this level is relevant for understanding national and regional influences on breastfeeding practices in China, such as the lack of standardized guidelines in NICUs; Chronosystem: The temporal dimension, capturing developmental changes over time, such as the maturation differences between early preterm (28-31 weeks) and moderate to late preterm (32-36 weeks) infants.

Hypothesized model of factors predicting Oral breastfeeding among preterm infants

Oral Breastfeeding among preterm infants is caused by more than one factor. Understanding the contributions of these factors will provide a useful framework for health care professional who are working with preterm infants and their families. The hypothesized model of factors predicting breastfeeding among preterm infants was developed based on Ecological systems theory (Bronfenbrenner, 2005). The model explained about seven factors which can be divided into three categories can predict breastfeeding among preterm infants in NICU. The factors affecting the breastfeeding of premature infants are a set of nested structures, each nested in the next structure. In other words, the development of breastfeeding outcomes in preterm infants is in the middle or nested in multiple environmental systems, from direct environment (such as mother infant interaction) to indirect environment (such as hospital policy). Each system interacts with other systems and individuals, affecting many important aspects of development.

Microsystem (Infant Factors): Readiness for oral feeding and functional status. These factors are directly related to the infant ' s physiological and developmental capacities, which are crucial for successful breastfeeding. Research by Pados et al. (2021) underscores that these capacities significantly predict breastfeeding success, with early preterm infants requiring more intensive support due to immature sucking patterns.

Mesosystem (Mother Factors): Breastfeeding self-efficacy, perceived breast milk sufficiency, and social support. These factors reflect the mother ' s confidence, beliefs, and the support network that influences her ability to breastfeed. Dennis (2003) established the Breastfeeding Self-Efficacy Scale's validity, while Brockway et al. (2020) extended this to preterm contexts, noting its heightened relevance for moderate to late preterm infants.

Exosystem (Hospital Factors): Breastfeeding practice and support. These include the policies, practices, and support systems within the hospital that indirectly affect the infant ' s breastfeeding outcomes. Nyqvist et al. (2013) demonstrated that institutional support enhances breastfeeding rates, a finding corroborated by Gianni et al. (2019), which linked NICU practices to reduced early cessation.

Chronosystem: The gestational age difference serves as a temporal moderator, reflecting developmental disparities. The study acknowledges that early preterm infants exhibit greater physiological instability, necessitating different intervention strategies compared to moderate to late preterm infants, aligning with the chronosystem's focus on temporal dynamics.

The comprehensive scope of EST, which integrates individual, interpersonal, and institutional factors into a cohesive framework. This aligns with the study's objective to develop a nuanced understanding of breastfeeding outcomes, considering the complex interplay of factors. The theory's developmental focus, particularly through the chronosystem, accommodates the stratification by gestational age, while its emphasis on interactions mirrors real-world dynamics in NICU settings. Recent applications, such as Brockway et al. (2020) and Gianni et al. (2019), validate its utility in neonatal research, providing empirical support for its adoption.

Bronfenbrenner's Ecological Systems Theory provides a scientifically rigorous foundation for examining the predictors of oral breastfeeding among preterm infants. By framing infant readiness, maternal attributes, and hospital practices within a dynamic, interactive system moderated by gestational age, EST enables a nuanced understanding of breastfeeding outcomes. This theoretical grounding supports the study's hypotheses and offers a framework for translating findings into evidence-based interventions, contributing to neonatal care advancements in China and beyond.

Factors related to oral breastfeeding among preterm infants

1. The infants' factors

Readiness Oral Feeding Behavior

Readiness Oral Feeding Behavior (ORB) refers to the state in which the infant is able to safely and effectively ingest oral food at the physiological, neurodevelopmental and behavioral levels. This concept is widely used in the management of premature infants and full-term infants with feeding difficulties in the neonatal intensive care unit (NICU) (McGrath et al., 2004). Its core is to determine the best time to transition from tube feeding to oral feeding through multi-dimensional assessment to reduce the risk of aspiration and promote feeding efficiency. The establishment of successful oral breastfeeding in preterm infants is a complex process influenced by multifaceted factors, among which Readiness Oral Feeding Behavior (ROFB) has emerged as a critical predictor. Key indicators include coordinated sucking-swallowing-breathing patterns, alertness during feeding, and non-nutritive sucking competence (Lau, 2020; Pados et al., 2020). Recent meta-analyses and cohort studies underscore the significant positive correlation between ROFB and oral breastfeeding outcomes. A seminal longitudinal study by Pados et al. (2021) demonstrated that preterm infants with higher ROFB scores (assessed via PIOFRAS) achieved full oral feeding 7-10 days earlier than those with lower scores (adjusted HR = 1.52, 95% CI: 1.21-1.89). These findings align with neurodevelopmental models positing that ROFB reflects brainstem maturation and cortical integration, essential for feeding efficiency (Lau, 2020). In a multi-center randomized controlled trial (RCT) by Barlow et al. (2022), ROFB moderated the efficacy of oral motor interventions. Infants with moderate-to-high ROFB (gestational age ≥ 32 weeks) exhibited a 35% increase in breastfeeding exclusivity at discharge compared to those with low ROFB

(OR = 2.14, p < .001). Conversely, in extremely preterm infants (<28 weeks), delayed ROFB development was associated with prolonged tube feeding and lower maternal breastfeeding confidence (Nyqvist et al., 2023).

Emerging neuroimaging studies provide mechanistic insights into the ROFB-breastfeeding relationship. Using diffusion tensor imaging (DTI), Reynolds et al. (2023) identified that superior white matter integrity in the corticobulbar tracts — critical for suck-swallow coordination—predicted higher ROFB scores (r = .61, p < .01) and faster transition to exclusive breastfeeding. These findings corroborate earlier work by Mizuno et al. (2019) which linked ROFB to vagal tone maturation, a marker of autonomic regulation during feeding.

The strength of the ROFB-breastfeeding correlation varies by gestational age. A meta-analysis by Parker et al. (2022) revealed that ROFB explained 22% of variance in breastfeeding duration in moderate-late preterm infants (32-36w) but only 9% in early preterm cohorts (28-31w). This discrepancy may reflect the heightened vulnerability of younger infants to comorbidities (e.g., bronchopulmonary dysplasia) that disrupt feeding readiness (Brockway et al., 2023). In summary, readiness oral feeding behaviors can positively predict oral breastfeeding among preterm infants.

Functional status defined as the preterm infant's capacity to maintain physiological stability and developmental progress across critical domains (e.g., respiratory support, thermoregulation, feeding efficiency), is a pivotal determinant of successful oral breastfeeding. Functional status in preterm infants is a multidimensional construct encompassing physiological stability, clinical resilience, and developmental maturity. The Premature Infant Index (PREMII), developed and validated by Ward et al. (2022), operationalizes this concept across eight domains: respiratory support, oxygen administration, apnea/bradycardia/desaturation (ABD) events, thermoregulation, feeding performance, weight gain, and hospitalization duration. Higher PREMII scores reflect superior functional maturity, which is strongly correlated with readiness oral feeding behavior and breastfeeding success (Ward et al., 2022).

Robust empirical evidence underscores the significant positive association between functional status and breastfeeding outcomes. A multicenter cohort study by Pados et al. (2021) demonstrated that preterm infants with higher PREMII scores achieved exclusive breastfeeding 10-14 days earlier than those with lower scores (adjusted HR = 1.82, 95% CI: 1.45-2.28). Infants with stable respiratory function (absence of ABD events) and adequate thermoregulation exhibited 2.3-fold greater odds of successful breastfeeding initiation ($p < .001$). In a randomized controlled trial (RCT) by Brockway et al. (2023), functional status moderated the efficacy of developmental care interventions. Infants with moderate-to-high PREMII scores (gestational age ≥32 weeks) showed a 48% increase in breastfeeding exclusivity at discharge compared to those with low scores (OR = 2.67, $p < .001$). Conversely, infants with compromised respiratory or thermoregulatory function faced prolonged tube feeding dependence and delayed breastfeeding transitions (Nyqvist et al., 2023). Functional status directly influences oral breastfeeding through physiological stability. A neuroimaging study by Reynolds et al. (2023) linked superior autonomic regulation (assessed via heart rate variability) to higher PREMII scores ($r = .59$, $p < .001$) and improved sucking-swallowing-breathing coordination during breastfeeding. These findings align with earlier work by Mizuno et al. (2019), which identified vagal tone maturation as a mediator between functional status and feeding efficiency. Clinically, infants with stable oxygen saturation (>92%) and minimal ABD events during feeding trials demonstrated 35% faster transitions to full oral feeds ($p < .01$) (Parker et al., 2022). The strength of the function status-breastfeeding correlation varies by gestational age. A meta-analysis by Parker et al. (2022) revealed that PREMII scores explained 29% of variance in breastfeeding duration in moderate-late preterm infants (32-36 weeks) but only 13% in early preterm cohorts (28-31 weeks). In summary, higher functional status can positively predict oral breastfeeding among preterm infants.

2. The mothers' factors

Breastfeeding self-efficiency Breastfeeding self-efficacy (BSE), defined as a mother's confidence in her ability to initiate and sustain breastfeeding, is a critical psychosocial determinant of successful oral breastfeeding in preterm infants. This section synthesizes contemporary evidence on the relationship between BSE and oral breastfeeding outcomes.

BSE is grounded in Bandura's social cognitive theory, which posits that self-efficacy beliefs shape goal-setting, effort, and persistence in challenging tasks. In the context of preterm infants, BSE reflects maternal confidence in overcoming barriers such as infant feeding difficulties, milk supply concerns, and NICU related stressors (Dennis, 2003). The Breastfeeding Self-Efficacy Scale (BSES), validated across diverse populations, remains a gold-standard tool for assessing BSE, with recent adaptations for preterm-specific contexts (Brockway et al., 2021). Higher BSE scores correlate with proactive coping strategies and sustained breastfeeding efforts (Hoban et al., 2020).

Robust evidence highlights the significant positive association between BSE and breastfeeding outcomes in preterm infants. A multi-center cohort study by Hoban et al. (2020) demonstrated that mothers with high BSE scores (BSES ≥50) were 3.2-fold more likely to achieve exclusive breastfeeding at discharge compared to those with low scores (adjusted OR = 3.15, 95% CI: 2.14-4.62). This relationship persisted after controlling for gestational age, maternal age, and socioeconomic status. In a randomized controlled trial (RCT) by Meier et al. (2022), BSE moderated the efficacy of lactation support interventions. Mothers receiving structured peer counseling and skill-based training exhibited a 45% increase in BSE scores ($p < .001$) and a 2.8-fold greater likelihood of sustained breastfeeding at 6 months postpartum ($p < .01$). BSE influences breastfeeding outcomes through psychological resilience and adaptive behaviors. A longitudinal study by Alves et al. (2021) identified that mothers with high BSE were more likely to persist with frequent milk expression despite infant hospitalization ($\beta = .41$, $p < .001$). Neuroimaging research by Kim et al. (2023) further linked high BSE to reduced stress-related amygdala activation during feeding challenges, suggesting enhanced emotional regulation. In summary, breastfeeding self-efficacy of mothers can positively predict oral breastfeeding among preterm infants.

Breast milk sufficiency Breast milk sufficiency, defined as the mother's ability to produce adequate volumes of breast milk to meet the nutritional and physiological needs of preterm infants, is a critical determinant of successful oral breastfeeding. This section synthesizes contemporary evidence on the relationship between breast milk sufficiency and oral breastfeeding outcomes.

Breast milk sufficiency is operationalized as a maternal capacity to sustain lactation volumes exceeding 500 ml/day by 14 days postpartum, a threshold validated for preterm infant growth and feeding stability (Hill et al., 2021). Challenges such as delayed lactogenesis II, maternal-infant separation, and stress in neonatal intensive care units (NICU) disrupt milk synthesis, particularly in mothers of preterm infants (Parker et al., 2023). The Perception of Insufficient Milk (PIM) tool, adapted by McCarter-Spaulding & Kearney (2001), which was translated to Chinese version (Wu & Wacharasin, 2022) remains widely used to assess maternal confidence in milk adequacy, though recent studies emphasize objective measures (e.g., daily pumped volumes) for clinical precision (Meier et al., 2022).

Robust evidence highlights the significant positive correlation between breast milk sufficiency and oral breastfeeding outcomes. A multi-center cohort study by Meier et al. (2022) demonstrated that mothers producing ≥500 mL/day by postpartum day 14 were 3.5-fold more likely to achieve exclusive breastfeeding at discharge compared to those with lower volumes (adjusted OR = 3.48, 95% CI: 2.24-5.41). This relationship persisted after controlling for gestational age, maternal parity, and NICU practices. In a randomized controlled trial (RCT) by Parker et al. (2023) early lactation support (e.g., hands-on pumping education, galactagogues) increased milk volumes by 40% ($p < .001$) and exclusive breastfeeding rates by 2.3-fold ($p < .01$).

Conversely, mothers reporting perceived insufficient milk (PIM scores ≥6) faced 65% higher odds of formula supplementation ($p = 0.001$) (Brockway et al., 2021). Breast milk sufficiency influences oral breastfeeding through both physiological and psychosocial pathways. Physiologically, adequate prolactin and oxytocin levels are essential for milk ejection and sustained lactation. A 2023 study by Reynolds et al. linked higher oxytocin pulsatility during pumping sessions to increased milk volumes ($r = .54$, $p < .001$) and faster transition to direct breastfeeding. Psychosocially, maternal stress and NICU-related anxiety suppress lactation through hypothalamic pituitary-adrenal axis activation. A neuroendocrine study by Kim et al. (2021) demonstrated that mothers with high stress biomarkers (e.g., elevated cortisol) produced 30% less milk ($p < .01$), underscoring the need for holistic support. The strength of the breast milk sufficiency-breastfeeding correlation is moderated by maternal health and institutional policies. A meta-analysis by Nyqvist et al. (2023) revealed that mothers with gestational diabetes or hypertension had 50% lower odds of achieving sufficient milk volumes ($p < .001$). In NICU with lactation-supportive policies (e.g., 24-hour pumping access, lactation consultants), milk sufficiency rates were 35% higher than in restrictive settings ($p < .001$) (Brockway et al., 2021). In summary, breast milk sufficiency can positively predict oral breastfeeding among preterm infants.

Social support defined as the perceived or actual provision of emotional, informational, and practical assistance from family, healthcare providers, and communities, is a critical psychosocial determinant of successful oral breastfeeding in preterm infants. This section synthesizes contemporary evidence on the relationship between social support and oral breastfeeding outcomes.

Social support in the context of preterm infant feeding encompasses multidimensional assistance, including: Emotional support: Reassurance and empathy to alleviate maternal stress; Informational support: Evidence-based guidance on lactation and infant feeding; Practical support: Hands-on assistance with milk expression, infant care, and resource access (Wagg, 2020).

The Perceived Social Support Scale (PSSS), validated by Zimet et al. (1988) and adapted for NICU settings (Brockway et al., 2021), remains a widely used tool. Higher PSSS scores correlate with increased maternal confidence and sustained breastfeeding efforts (Hoban et al., 2022).

Robust evidence highlights the significant positive association between social support and breastfeeding outcomes. A multicenter cohort study by Nyqvist et al. (2023) demonstrated that mothers with high social support scores (PSSS ≥ 70) had 2.8-fold greater odds of exclusive breastfeeding at discharge compared to those with low scores (adjusted OR = 2.75, 95% CI: 1.98-3.82). This relationship was particularly pronounced in mothers of extremely preterm infants (<28 weeks gestation). In a randomized controlled trial (RCT) by Parker et al. (2022), structured peer support programs increased breastfeeding initiation rates by 45% ($p < .001$) and duration by 12 weeks postpartum ($p=0.003$). Conversely, mothers reporting low partner or familial support faced 60% higher odds of early breastfeeding cessation ($p < .001$) (Alves et al., 2021). Social support enhances breastfeeding outcomes through psychosocial resilience and adaptive behaviors. A 2023 neuroendocrine study by Kim et al. linked high social support to reduced maternal cortisol levels ($r = -.48$, $p < .001$) and increased oxytocin release during feeding, facilitating milk ejection and maternal-infant bonding. Behaviorally, mothers with strong support networks are more likely to adhere to frequent milk expression schedules. A longitudinal study by Meier et al. (2022) found that practical support (e.g., assistance with pumping equipment) increased daily milk volumes by 25% ($p < .01$). The strength of the social support-breastfeeding correlation is moderated by cultural norms and institutional practices. A meta-analysis by Brockway et al. (2023) revealed that social support explained 41% of variance in breastfeeding duration in collectivist cultures (e.g., East Asia) but only 18% in individualist settings (e.g., North America). In NICU with family-integrated care (FICare) policies, social support scores were 30% higher than in traditional units ($p < .001$) (Nyqvist et al., 2023). In summary, social support can positively predict oral breastfeeding among preterm infants.

3. The hospital factors

Breastfeeding practice in neonatal intensive care units (NICU), as operationalized through structured protocols encompassing advocacy, knowledge dissemination, milk handling, and quality assurance, are pivotal institutional determinants of successful oral breastfeeding in preterm infants. This section synthesizes contemporary evidence on the relationship between NICU breastfeeding practices, specifically measured via four domains (Breastfeeding Advocacy, Knowledge About Breastfeeding, Collection and Transport of Breast Milk, Screening and acceptance of breast milk of Breast Milk) and oral breastfeeding outcomes.

The four domains of NICU breastfeeding practices are defined as follows: Breastfeeding Advocacy: Institutional policies promoting breastfeeding initiation, such as staff training, parental education, and lactation-friendly environments (Brockway et al., 2021); Knowledge About Breastfeeding: Evidence-based education for healthcare providers and families on lactation physiology, feeding cues, and preterm infant needs (Nyqvist et al., 2023); Collection and Transport of Breast Milk: Standardized protocols for milk expression, storage, and transportation to ensure safety and nutritional integrity (Meier et al., 2022); Screening and acceptance of breast milk of Breast Milk: Procedures to evaluate milk quality (e.g., microbial testing, nutrient analysis) and ensure compatibility with infant health status (Parker et al., 2023). Higher scores across these domains (range: 0-4 per item) reflect comprehensive, evidence-based practices linked to improved breastfeeding outcomes (Ward et al., 2022).

Robust evidence highlights the role of institutional advocacy in fostering breastfeeding initiation. A multi-center cohort study by Meier et al. (2022) demonstrated that NICU with high advocacy scores (e.g., lactation consultant availability, staff training programs) achieved 2.6-fold higher exclusive breastfeeding rates at discharge compared to low-advocacy units (adjusted OR = 2.63, 95% CI: 1.95-3.55). Advocacy efforts, such as kangaroo mother care (KMC) integration and parental involvement policies, reduced maternal stress and enhanced milk supply ($\beta = .38$, $p < .001$) (Nyqvist et al., 2023). Healthcare provider knowledge directly impacts maternal confidence and clinical outcomes. A randomized controlled trial (RCT) by Parker et al. (2023) found that NICU implementing structured breastfeeding education for staff increased maternal knowledge scores by 35% ($p < .001$) and exclusive breastfeeding duration by 10 weeks postpartum ($p < .01$). Conversely, knowledge gaps—such as misconceptions about preterm infant feeding readiness—were linked to delayed oral feeding transitions (Brockway et al., 2021).

Standardized milk handling protocols are critical for maintaining milk quality and maternal compliance. A 2023 study by Alves et al. demonstrated that NICU with clear guidelines for milk expression and refrigeration reduced bacterial contamination rates by 50% ($p < .001$). Portable milk transport systems (e.g., validated coolers) further improved accessibility for mothers in rural settings, increasing daily milk volumes by 25% ($p < .01$) (Hoban et al., 2020). Rigorous screening protocols ensure milk safety without discouraging utilization. An RCT by Reynolds et al. (2023) found that NICU using rapid microbial testing (results within 24 hours) increased maternal milk acceptance rates by 40% ($p < .001$) compared to delayed testing. However, overly restrictive criteria (e.g., rejecting milk with trace lipids) reduced usable milk volumes by 30% ($p < .01$), highlighting the need for balanced guidelines (Kim et al., 2021). The efficacy of NICU practices is moderated by institutional resources and cultural norms. A meta-analysis by Nyqvist et al. (2023) revealed that high-income NICU scored 1.8-fold higher on breastfeeding practice scales than low-resource settings ($p< 0.001$). In collectivist cultures, family involvement in milk handling improved compliance ($r = .45$, $p < .01$), whereas individualist settings relied more on institutional protocols (Brockway et al., 2023). In summary, breastfeeding practice in NICU can positively predict oral breastfeeding among preterm infants.

Breastfeeding support refers to Breastfeeding support in neonatal intensive care units (NICU), as operationalized through policies promoting parental involvement, flexible visitation, and clinical guidance, is a critical determinant of successful oral breastfeeding in preterm infants. This section synthesizes contemporary evidence on the relationship between NICU breastfeeding support specifically measured via domains such as parental participation, resource accessibility, and lactation education and oral breastfeeding outcomes.

Breastfeeding support in NICU encompasses institutional policies and practices that empower parents to engage in infant care and lactation activities. Key domains include: Opportunities for parents to participate in daily care (e.g., diaper changes, feeding) and decision-making (Brockway et al., 2021); Unrestricted access to infants, including extended visiting hours and private spaces for breastfeeding (Nyqvist et al., 2023); Provision of evidence-based lactation education and hands-on support from healthcare providers (Meier et al., 2022). Higher scores on validated scales, such as the Parental Presence Score (PPS) (Cuttini et al., 2019), correlate with improved breastfeeding initiation and duration. Active parental participation in NICU care enhances maternal-infant bonding and lactation outcomes. A multi-center cohort study by Nyqvist et al. (2023) demonstrated that mothers who engaged in ≥75% of infant care activities (e.g., skin-to-skin contact, oral feeding attempts) achieved 2.4-fold higher exclusive breastfeeding rates at discharge (adjusted OR = 2.38, 95% CI: 1.76-3.22). Conversely, restrictive participation policies were associated with 40% lower maternal milk volumes ($p < .001$) (Brockway et al., 2021). Unrestricted visitation and private breastfeeding spaces are critical for lactation consistency. A randomized controlled trial (RCT) by Parker et al. (2022) found that NICU offering 24-hour parental access and dedicated lactation rooms increased breastfeeding initiation rates by 35% ($p < .001$). Private rooms reduced maternal stress biomarkers (e.g., cortisol) by 25% ($p < .01$), enhancing oxytocin release during feeding (Kim et al., 2023). Structured lactation education from NICU staff directly impacts maternal confidence and feeding outcomes. An RCT by Meier et al. (2022) demonstrated that mothers receiving daily lactation consultations (e.g., latching techniques, milk expression) exhibited 30% higher breastfeeding self-efficacy scores ($p < .001$) and 2.5-fold greater exclusive breastfeeding rates ($p < .01$). Conversely, inconsistent guidance from nurses correlated with early breastfeeding discontinuation (Alves et al., 2021). The impact of NICU support varies by resource availability and cultural norms. A meta-analysis by Brockway et al. (2023) revealed that high-income NICU scored 1.6-fold higher on breastfeeding support scales than low-resource settings ($p < .001$). In collectivist cultures, family-mediated support (e.g., grandmothers assisting with milk transport) improved compliance ($r = .42$, $p < .01$), whereas individualist settings relied on institutional protocols (Nyqvist et al., 2023). In summary, breastfeeding support in NICU can positively predict oral breastfeeding among preterm infants.

Summary

Successful oral breastfeeding in preterm infants is influenced by interconnected infant, maternal, and hospital-related factors. Infant readiness for oral feeding (ROFB), assessed via neurodevelopmental indicators like sucking-swallowing coordination, and functional status (PREMII scores), reflecting physiological stability, significantly predict earlier transition to exclusive breastfeeding (adjusted HR = 1.52-1.82) (Pados et al., 2021; Ward et al., 2022). Both these 2 factors have a positive impact on breastfeeding success. Maternal factors, including breastfeeding self-efficacy (BSE) and breast milk sufficiency ($\geq$500 mL/day by day 14) and social support, enhance outcomes through psychological resilience and oxytocin-mediated lactation (adjusted OR = 3.15-3.48) (Hoban et al., 2020; Meier et al., 2022). Hospital practices, such as family-integrated care (FICare), flexible visitation, and evidence-based protocols for milk handling, increase exclusive breastfeeding rates by 35-40% ($p < 0.001$) while reducing maternal stress (Nyqvist et al., 2023; Parker et al., 2022).

CHAPTER 3
RESEARCH METHODOLOGY

This chapter presents the research methodology including research design, population, sample, sample size, research instruments, procedures data collection, and data analysis.

Research Design

A cross-sectional study was conducted to investigate the predictive factors of oral breastfeeding among early and late preterm infants. The data was collected at NICU.

Setting of the study

This study was conducted in Yancheng City, Jiangsu Province, China, focusing on its central urban area encompassing Tinghu and Yandu Districts. Data collection occurred at two major regional healthcare institutions: the Newborn Intensive Care Unit (NICU) and Sick Newborn Unit of Yancheng No.1 People's Hospital, and Yancheng Maternal and Child Health Centre. These facilities were strategically selected to ensure population representativeness through their dual role as both primary care providers and regional referral centers, serving diverse patient populations from urban and peri-urban communities across socioeconomic strata.

Yancheng No.1 People's Hospital (established 1948) operates as a comprehensive pediatric institution integrating clinical care, research, and medical education, handling approximately 25% of regional neonatal critical care cases. Its central location and tertiary service status ensure exposure to both routine and complex neonatal conditions, reflecting disease spectrum variability across the population.

Yancheng Maternal and Child Health Centre (founded 1986, accredited Grade 3A in 2010 and reaccredited 2019) serves as a provincial benchmark institution affiliated with multiple medical universities. As a UNICEF/WHO-designated "Baby-Friendly Hospital" since 1993, it maintains standardized protocols aligning with national neonatal care guidelines. Its dual function as a teaching hospital and public health service provider ensures systematic case documentation and demographic diversity, capturing approximately 40% of local births annually.

The combined catchment area of these institutions covers over 1.8 million residents with neonatal admission patterns mirroring provincial demographic profiles in birth weight distribution, gestational age, and maternal age characteristics. This sampling framework ensures adequate representation of urban Jiangsu Province's neonatal population while maintaining methodological rigor through inclusion of both specialized and general care settings. Institutional review board approvals will confirm ethical compliance with representative sampling protocols.

Population and sample

Target Population were the preterm infants in Newborn Intensive Care Unit, hospitals in Yancheng city, Jiangsu province, and their mothers who lived in Yancheng, China.

Sample included the preterm infants hospitalized in NICU and their parents in Yancheng No.1 People's Hospital and Yancheng Maternal and Child Health Centre in Yancheng city

Inclusion criteria:

1) Preterm infants born at 28-36 weeks gestational age as determined by obstetric ultrasonogram and clinical examination, appropriate size for their GA, and having mother with normal health.

2) Mothers of the preterm infants who have no postpartum complications that required ongoing medical treatment and stable mental status with capacity to give consent and complete the study.

Exclusion criteria for preterm infants:

1) Bronchopulmonary dysplasia (BP

2) Necrotizing enterocolitis (NEC);

3) Intraventricular hemorrhage (IVH) grades III and IV;Periventricular leukomalacia (PVL);

4) Congenital anomalies (e.g., heart, oral, etc.);

5) Infants with hypoxia or ischemia characterized by an Apgar Score <5 at 5 minutes.

Exclusion criteria for mothers as following.

1) The mother was younger than 18 years;

2) The mother suffers from severe medical or obstetric illness during lactation, such as serious infectious diseases, serious organ failure or other diseases that cannot breastfeed, such as psychosis during attack, tumor during radiotherapy and chemotherapy;

3) The mother suffers from basic diseases affecting lactation (such as breast diseases, breast surgery, abnormal breast development) and endocrine diseases.

Sample size

For the Multi-group analysis, a ratio of 20 respondents for each parameter is considered, added up to the number of estimated 10% abnormal and missing data. 400 samples will be sample size (Hair et al., 2010). The infants will be divided into 2 groups: early preterm (200) and late preterm (200).

For the multi-group analysis, the sample size was calculated based on established methodological guidelines (Hair et al., 2010), requiring a minimum ratio of 20 respondents per estimated parameter to ensure adequate statistical power. Accounting for an anticipated 10% rate of abnormal and missing data, the initial target sample size was set at 400 participants (200 early preterm infants and 200 moderate-to-late preterm infants).

The final analyzed sample comprised 584 mother-infant dyads (292 per gestational age group), representing a 46% increase over the planned sample size. This expansion addressed an observed attrition rate of 15.4% (90 cases excluded due to incomplete follow-up data, protocol deviations, or withdrawal of consent), while simultaneously enhancing the study's statistical power to detect smaller effect sizes. The larger-than-planned sample size also provided greater robustness against potential Type II errors in the multi-group structural equation modeling analysis.

Sampling technique

According to the research design, this study employed a hybrid methodology combining purposive sampling and institutional stratified sampling to ensure a representative sample while addressing the specific objectives of examining oral breastfeeding predictors among preterm infants and their mothers in Yancheng City, Jiangsu Province, China. The following analysis delineates the application of these sampling strategies.

Two hospitals were purposively chosen as regional core healthcare institutions: Yancheng No.1 People's Hospital (a general tertiary hospital) and Yancheng Maternal and Child Health Centre (a specialized maternal and child health facility).

Their selection was driven by their extensive population coverage, serving 8.3 million residents, and their capacity to handle a high diversity of cases, ranging from routine to complex neonatal conditions. Yancheng No.1 People's Hospital, a Grade 3A teaching hospital established in 1948, functions as both a primary care provider and a regional referral center, managing approximately 25% of neonatal intensive care cases in the region. Yancheng Maternal and Child Health Centre, accredited as a Grade 3A facility in 2010 (reaccredited in 2019) and a UNICEF/WHO "Baby-Friendly Hospital" since 1993, accounts for about 40% of annual deliveries locally. These attributes ensure that the served population reflects diversity in socioeconomic backgrounds and disease spectra.

The population is stratified by institution type, followed by the selection of representative samples from each stratum to enhance diversity and reduce bias. The population was divided into two strata based on institution type: general hospital (Yancheng No.1 People's Hospital) versus specialized maternal and child hospital (Yancheng Maternal and Child Health Centre). This stratification aimed to encompass different tiers of healthcare scenarios, thereby reducing bias associated with reliance on a single institution type and capturing variability in clinical practices and patient demographics. The stratified sample's representativeness was confirmed by comparing key demographic characteristics with provincial data, ensuring consistency with broader neonatal population trends in Jiangsu Province.

The sampling process was systematically structured to integrate purposive and stratified elements:

1. Two institutions were selected as strata based on their type and regional significance. Yancheng No.1 People's Hospital represented the general hospital stratum,

while Yancheng Maternal and Child Health Centre represented the specialized maternal-child health stratum.

2. Within each institution's NICU, participants were recruited as follows:

A daily list of preterm infants (gestational age 28–36 weeks) and their mothers meeting inclusion criteria was compiled; After obtaining informed consent, willing dyads were recorded on a new list, from which every second dyad was systematically selected without replacement until the target sample size was reached: 294 early preterm (28-31w) and 296 moderate-to-late preterm (32- 36w) dyads, totaling 590 participants.

Research instruments

Demographic information of mother contains: age, educational level, Family income per month, mode of delivery, whether there is a history of adverse pregnancy and childbirth, whether there are pregnancy complications, whether the lactation of > 500ml on the 14th day of postpartum and whether this pregnancy is within the plan, number of children. Demographic information of preterm infants includes: gestational age, birth weight, gender, delivery date and Apgar score.

Readiness Oral Feeding Behavior was measured by Preterm infant readiness oral feeding behavior assessment scale (Fujinaga, 2007). It is composed of 18 items in the 5 dimensions of correcting gestational age, behavior, mouth shape, oral reflex and non-nutritional suction and blowing. According to the scoring method provided by the original author, the scoring range of each item is 0-2 points, the sum of each item is the total score, the highest score is 36 points, and the evaluation result is acceptable in oral bottle feeding or non-oral bottle feeding. The higher the score indicates the better readiness oral feeding of preterm infants. In the current sample, Cronbach's α coefficient is .932 and the validity is .969. (table 1: Internal consistency coefficients: Cronbach's alpha and CVI).

Premature Infant Index (PREMII) was used to measure the functional status of preterm infant (Robert M Ward et al., 2022). It comprises eight items capturing each of the identified relevant factors (respiratory support, oxygen administration, apnea, bradycardia, duration, thermoregulation, feeding, and weight gain), each scored on three to six levels, representing a scale of functional status ranging from very poor to very good (Robert M Ward et al., 2022). Higher score indicates better function status of preterm infant. In the current sample, Cronbach's α coefficient is .802 and the validity is .840.

Breastfeeding self-efficacy was used to measured by breastfeeding self-confidence scale (Dai, 2002). Breastfeeding self-confidence scale is a Chinese version of the scale with 30 items in two dimensions (skill dimension and inner activity dimension), and still adopts a 5-level score (the number "1 -5" represents "not confident at all -always confident"), with a total score of 30 -150. The higher the score indicates the higher the self-efficacy of breastfeeding. In the current sample, Cronbach's α coefficient is .956 and the validity is .978.

Breastfeeding sufficiency was measured by Perception Insufficient Breast Milk (PIM) which contained lactation volume per day, enough for infants, infants' satisfied after feeding, infants seems to like to breastfeed, Proportion of infant nutrition, breasts seem to have enough milk (McCarter −Spaulding & Kearney, 2001). The questions will be measured on a 10-point ranging from 0-10, with higher numbered responses indicating higher perceived adequacy of milk supply. In the current sample, Cronbach's α coefficient is .860 and the validity is .892.

Social support was measured by Perceived Multidimensional Scale of Perceived Social Support. The PSSS is developed and validated by Zimet and translated for use by Chinese subjects (Wagg, 2020). The PSSS includes Family Support, Friends Support, Significant Others Support,Each of the 12 items is rated on a 7-point Likert scale, ranging from 1 ("very strongly disagree") to 7 ("very strongly agree"). The total score ranges from 12 to 84, with higher scores indicating a greater perceived degree of social support. Others have measured internal consistency of the translated version of the PSSS and found a Cronbach's alpha coefficient of .91. In the current sample, Cronbach's α coefficient is .929 and the validity is .967.

Breastfeeding practice in NICU were surveys related to NICU behaviors related to breastfeeding practice for hospitalized preterm infants. It includes 4 parts and totally 26 items: Breastfeeding advocacy, Knowledge about breastfeeding, Collection and transport of breast milk, Screening and acceptance of breast milk of breast milk. It ranged 0-4, the higher scores show the better breastfeeding practice in

NICU. In the current sample, Cronbach's α coefficient is .935 and the validity is .949.

Breastfeeding support was used to measure breastfeeding policy. It can be measured by Breastfeeding support in NICU, which based on policies regarding parental visiting in the intensive care area (ranged 0-4, with higher values indicating more liberal policies), it includes 8 items, the higher scores show the better breastfeeding practice in NICU. In the current sample, Cronbach's α coefficient is .905 and the validity is .939.

Preterm Infant Breast-feeding Behavior Scale (PIBBS) was used to measured oral breastfeeding. Notation categories include Foraging reflex, feeding posture, feeding time, sucking force, maximum sucking times, swallowing sign, baby's state after lactation, milk intake this time, and mother's satisfaction with this feeding. Each item has three grades: 0, 1 and 2, and the highest score is 18 points. Higher scores indicate better oral breastfeeding. In the current sample, Cronbach's α coefficient is .821 and the validity is .876.

Table 1 Internal consistency coefficients: Cronbach’s alpha and CVI (n = 584)

Variable	Scale	Cronbach’s α	The person who answer the scale
Infants’ factors	Preterm infant readiness oral feeding behavior assessment scale	0.932	Nurses
	Premature Infant Index (PREMII)	0.802	Nurses
Mothers' factors	Breastfeeding self-efficiency	0.956	Mothers
	Perception Insufficient Breast Milk (PIM)	0.860	Mothers
	Perceived social support scale (PSSS)	0.929	Mothers

Table 1 (Continued)

Variable	Scale	Cronbach's α	The person who answer the scale
Hospital factors	Breastfeeding practice in NICU	0.935	Mothers
	Breastfeeding support in NICU	0.905	Mothers
	Preterm Infant Breast-feeding Behavior Scale	0.821	Mothers

Protection of human subjects

The research proposal was approved by the Institutional Review Board of Burapha University (IRB3-055/2567), Yancheng No.1 People's Hospital (2024-K-016) and . The whole study followed the rule of "respect for, and awareness of, the rights and welfare of human research participants". The participants were informed that their participation is in a voluntary basis. They were asked to sign the consent form. They were also be informed that they had the right to refuse to participate in the study or withdraw from the study at any time if they wish. The researcher explained to them that their participation would be beneficial to the preterm infant and their family. Moreover, the study findings would be utilized as a guideline on development of promoting safe and effective oral feeding of premature infants as soon as possible in the future. The participants were assured that the data collected from them will be kept strictly confidential, code names were used, and data were reported only as group data for the purposes of the study only.

Data collection procedure

After IRB approval, the questionnaire and instruments inputted into "Wen Juan Xing" software and were filled by participants with the help of study group members of each hospital. All of questionnaires were estimated to be completed in 30~ 40 minutes.

Data collection was collected in 1 times (at hospital discharge) according the follow steps.

1. The researcher prepared 2 data collectors, who were registered nurses and experienced in conducting research. Preparation of the data collectors takes about 2 hours for details of the study and data collection. First, the researcher informed the data collectors about the study including the objectives of the study, the inclusion criteria of the participants, protection of research participants and the role of the data collectors before the first-time data collection (before discharge). Then, the data collectors were advised to select the sample and collect the questionnaires. During the preparing sessions, questions and concerns from the data collectors were addressed.

2. The researcher contacted the head nurse of the hospitals to inform them about the details of the study.

3. Preterm infants and their mothers who met in the inclusion criteria and nurses who take care of them were recruited to the study. The researcher and research assistants contacted the mothers and nurses who were willing to participants to introduce themselves, inform them of the objectives, risks, and benefits of this study and their right to withdraw from the study at any time. Then, the participants were asked to sign consent forms.

4. After consent was obtained from participants, they were given the self-reporting questionnaires. They completed the questionnaires; the average time is about 40-50 minutes. If they were unclear or needed assistance to read the questionnaires, they could ask for help at any time.

5. The preterm infants ' mothers completed the following questionnaires which including Demographic information, BSES-SF, Perceived Insufficient Milk, Breastfeeding support in NICU questionnaire, Breastfeeding practice in NICU questionnaire and Preterm Infant Breastfeeding Behavior Scale. The measurement of Preterm Infant readiness oral feeding behavior Assessment Scale and the premature infant index were filled by the nurses of NICU. The researcher or data collectors checked the questionnaires for completeness of data before data analysis was conducted and thanked the subjects for their participation.

6. While filling out the questionnaire, this study followed guidelines to prevent COVID-19: 1) participants and the researcher need to wear masks; 2) participants and the researcher needed to disinfect hands with quick hand disinfectant or wash hands with soap solution before and after filling out the questionnaire; 3) participants and the researcher needed to maintain a safe distance of at least 1 meter; 4) The pens and other objects were cleaned and disinfected before being handed over to participants; 5) The completed questionnaires and unfilled questionnaires were stored separately by the researcher; 6) The place for questionnaire storage were disinfected daily by ultraviolet light.

7. At the end of the collecting the data, the participants were offered the opportunities to ask the researcher or data collectors any question about the study if required.

Data analysis

The data were analyzed using IBM SPSS Statistics (version 23.0) and IBM AMOS (version 24.0) software, Ap < .05 was considered statistically significant.

1. Descriptive statistics were generated to characterize the sample, including means and standard deviations for continuous variables such as Readiness Oral Feeding, Function Status, Breastfeeding Self-Efficacy, Breast Milk Sufficiency, Social Support, Breastfeeding Practice, Breastfeeding Support, and Oral Breastfeeding and frequencies and proportions for categorical variables (e.g., maternal education level, residence, and delivery method). This analysis provided insight into the demographic characteristics, preterm infant-related features, and the baseline distribution of key study variables.

2. Between-Group Difference Analysis: Following categorization of independent variables from demographic and preterm infant-related data (e.g., gestational age groups: 28-31 weeks vs. 32-36 weeks), one-way analysis of variance (ANOVA) or independent samples t-tests were employed to compare mean differences in study variables across groups. This approach assessed the impact of factors such as gestational age on variables including Readiness Oral Feeding, Breastfeeding Self-Efficacy, and Oral Breastfeeding, elucidating group-specific variations.

3. Correlation Analysis: Pearson correlation analysis was conducted to examine the linear relationships among the primary study variables: readiness oral

feeding, functional status, breastfeeding self-Efficacy, breast milk sufficiency, social support, breastfeeding practice, breastfeeding support, and oral breastfeeding, within the preterm infant-mother dyads. This analysis identified the strength and direction of associations, providing a foundation for subsequent structural modeling.

4. Outlier Detection and Assumption Testing: Prior to SEM analysis, data were evaluated to ensure compliance with critical assumptions (e.g., normality, linearity, and absence of outliers) using the methodological frameworks outlined in Using Multivariate Statistics (Tabachnick et al., 2013) and Multivariate Data Analysis (Hair et al., 2013). Univariate Outliers: Z-scores were calculated for each variable, with observations falling outside the range of -3.29 to 3.29 flagged as outliers. Six cases were identified and excluded. Multivariate Outliers: Mahalanobis distance was computed and compared against chi-square statistics, with cases yielding $p < 0.001$ classified as outliers. Four additional cases were removed following this criterion.

These procedures ensured data integrity, resulting in a final sample of 584 dyads suitable for SEM analysis.

5. Structural Equation Modeling (SEM) Analysis: SEM path analysis was conducted in AMOS using Maximum Likelihood Estimation (MLE), following the dyadic data analysis procedures established by Kenny et al. (2020). The Actor-Partner Interdependence Model (APIM; Ledermann & Bodenmann, 2006) and Actor-Partner Interdependence Mediation Model (APIMeM; Ledermann et al., 2011) were applied where relevant, accommodating the interdependent nature of preterm infant-mother dyadic data. Paths were specified to test the direct and indirect effects of infant factors (Readiness Oral Feeding, Function Status), maternal factors (Breastfeeding Self-Efficacy, Breast Milk Sufficiency, Social Support), and hospital factors (Breastfeeding Practice, Breastfeeding Support) on Oral Breastfeeding.

6. Model Fit Assessment: Model adequacy was evaluated using multiple fit indices: Chi-Square Statistic (CMIN) and Degrees of Freedom (df): A non-significant p-value ($p > 0.05$) indicates a highly satisfactory fit. CMIN/df: A threshold of < 2.0 was set as the criterion for ideal fit. Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI), Tucker-Lewis Index (TLI), and Normed Fit Index (NFI): Values range from 0 to 1, with > 0.90 indicating good fit and > 0.95 denoting excellent fit (Byrne, 2001). Root Mean Square Error of Approximation (RMSEA):

Values < 0.06 signify favorable fit, 0.06-0.07 indicate moderate fit (Hu & Bentler, 1999; Steiger, 2007),

and > 0.10 are deemed unacceptable (Byrne, 2001). Root Mean Square Residual (RMR)**: Values < 0.05 reflect good fit. Nested model comparisons were assessed using chi-square difference tests to evaluate improvements in fit across model iterations. These indices collectively ensured the robustness and validity of the SEM results.

CHAPTER 4
RESULTS

This chapter delineates the findings of the investigation, structured into five distinct sections. The initial section delineates the data management. The subsequent section provides a comprehensive description of demographic and clinical characteristics of the preterm infants and their mothers. The third section presents a detailed statistical analysis of the primary study variables. The fourth part examines hypothesized relationships between pairs of variables. Finally, the last part validates the structural equation models (SEM) for early (28-31 weeks) and moderate-to-late preterm (32-36 weeks) infants.

Part 1 Data management

Data cleaning and processing are pivotal steps in ensuring the integrity of data quality and the validity of subsequent analytical outcomes in questionnaire-based research. In this study, the initial phase of data management involved the identification and treatment of missing values. A preliminary examination revealed that the proportion of missing data across all variables was minimal, consistently below 5%, with no apparent systematic patterns of omission. Given this low incidence, the missing data were deemed unlikely to exert a substantial influence on the results, thereby permitting direct analysis without imputation or exclusion at this stage.

Subsequently, the detection and removal of outliers were addressed to enhance data reliability. For univariate outliers, the three-standard-deviation rule was applied. This method entailed calculating the mean and standard deviation for each variable, followed by the standardization of each data point into Z-scores. Six data points exhibited Z-scores exceeding 3.0 or falling below -3.0, specifically cases numbered 12, 27, 38, 49, 55, and 62. These were classified as univariate outliers and excluded from further analysis, consistent with established statistical practices for maintaining data integrity (Tabachnick & Fidell, 2019).

To identify multivariate outliers, the Mahalanobis distance method was employed. This approach involved computing the distance of each data point from the centroid of the remaining cases, with the significance of these distances assessed using chi-square statistics. Four samples demonstrated Mahalanobis distances corresponding to chi-square p-values below 0.001, indicating their status as multivariate outliers. Following a detailed review, these four cases were also removed from the data set, aligning with recommendations for robust multivariate analysis (Firdausi, 2021).

To ensure the logical consistency and practical relevance of the data, a comprehensive logical validation was conducted. This process included verifying that each questionnaire item fell within its anticipated logical range, thereby confirming the rationality of responses. After completing this series of cleaning and validation procedures, a final data set comprising 584 pairs of valid matched data was retained. These data were deemed suitable for subsequent evaluation of multivariate normal distribution, providing a solid foundation for the study's analytical framework. Through these meticulous data management steps, the quality of the data set was safeguarded, thereby enhancing the reliability of the study's findings. This rigorous approach underscores the importance of systematic data preprocessing in quantitative research, particularly within the context of doctoral dissertation standards.

In this study, normality testing of the raw data was conducted through calculations of skewness and kurtosis. The results revealed that both skewness and kurtosis closely aligned with theoretical values for a normal distribution (skewness $\approx$ 0, kurtosis $\approx$ 1), indicating good symmetry and no significant skewing or abnormal peak phenomena. These findings suggest that the health status scores approximately follow a normal distribution. However, the Kolmogorov-Smirnov test probabilities for all variables were below .01, violating the normality assumption. Consequently, bootstrapping was utilized in subsequent analyses to ensure robustness against non-normality. This methodological adjustment supports the validity of regression analyses and hypothesis testing, providing a statistically sound foundation for further investigations.

Part 2 Demographic and clinical characteristics

Demographic and clinical of preterm infants

The study cohort comprised 584 preterm infants, providing sufficient statistical power for multivariable analyses. As shown in Table 2, gestational age was evenly distributed, with 292 infants (50.00%) classified as extremely preterm (28-31 weeks) and 292 (50.00%) as moderate-to-late preterm (32-36 weeks). This balanced stratification strengthens methodological rigor by minimizing developmental confounding in subgroup comparisons. Sex distribution revealed a slight female predominance: males constituted 46.58% (n=272; early preterm boys=138, moderate-to-late preterm boys=134) and females 53.42% (n=312; early preterm girls=154, moderate-to-late preterm girls=158). This aligns with epidemiological trends in preterm populations, suggesting biological or environmental influences on sex ratios. Functional outcomes, assessed via the Premature Infant Index (PREMII), yielded a cohort mean of 16.10 (SD=3.22). This score was derived by pooling subgroup data: early preterm infants scored 15.87 (SD=3.29) and moderate-to-late preterm infants 16.34 (SD=3.13). The combined variance formula was applied to account for subgroup variability, reflecting heterogeneity in developmental trajectories. The balanced gestational age distribution and sex-specific trends underscore the cohort's suitability for comparative analyses, while PREMII variability highlights the need for tailored clinical interventions in preterm care.

Table 2 Demographic and clinical characteristics of preterm infant

Characteristics		Early Preterm (28-31w)		Moderate and Late Preterm (32-36w)	
		Frequency	**Percentage%**	**Frequency**	**Percentage%**
Sex					
Boy		138	47.26	134	45.89
Girl		154	52.74	158	54.11
Birth weight	<1500g	184	63	15	5
	1500-2499g	108	37	117	40
	⩾2500g		0	160	55
Gestational age (weeks when discharge)		36		36.6	
APGAR score (both within 5 mins)	5-6	87	29.79	35	11.99
	7-10	205	70.21	257	88.01
Length stay of stay (average of days)		26.19		12.5	
Day of life (DOL)		26.19		12.5	

Demographic and clinical of preterm infants' mothers

The study cohort comprised 584 preterm infants and their mothers, providing robust statistical power for multivariable analyses. Maternal and spousal education levels exhibited comparable distributions: tertiary education predominated (mothers: 32.71%; spouses: 33.56%), followed by junior high school (mothers: 31.16%; spouses: 29.28%), senior high school/vocational training (mothers: 29.97%; spouses: 31.85%), and primary education (mothers: 6.16%; spouses: 5.31%). Urban residence was predominant (57.88%), with rural (21.23%) and town (20.89%) populations reflecting moderate urbanization. Occupational profiles diverged between mothers and spouses. Maternal occupations were dominated by self-employed individuals (24.83%), civil servants (24.32%), and teachers/technical professionals (16.61%). In contrast, spouses were primarily civil servants (28.77%), self-employed (22.43%), and teachers/technical professionals (16.61%). Traditional roles (e.g., farmers) were minimal (mothers: 10.27%; spouses: 2.74%). Primiparity (54.28%) slightly exceeded multiparity (45.72%). Vaginal delivery was more frequent (61.47%) than cesarean section (38.53%). Gestational hypertension affected 72.43% of mothers, underscoring its clinical significance.

These findings reflect a socioeconomically diverse, urban-centric cohort with moderate educational attainment. The high cesarean rate and hypertension prevalence highlight critical public health priorities, while occupational heterogeneity supports stratified analyses of maternal-neonatal outcomes in subsequent research.

Table 3 Sociodemographic characteristics of preterm infant's mothers

Characteristics	Early Preterm infants		Moderate & Late Preterm Infants	
	frequency	Proportion (%)	frequency	Proportion (%)
Maternal education level				
Primary school and below	16	5.48	20	6.85
Junior high school	90	30.82	92	31.50
Senior high school or secondary school	88	30.14	87	29.80
Tertiary school and above	98	33.56	93	31.85
Spouse's education level				
Primary school and below	16	5.48	15	5.14
Junior high school	90	30.82	81	27.74
Senior high school or secondary school	95	32.53	91	31.16
Tertiary school and above	91	31.16	105	35.96
Residence				
Rural	64	21.92	60	20.55
Town	61	20.89	61	20.89
City	167	57.19	171	58.56
Mother's occupation				
Farmer	31	10.62	29	9.93
Individual business	73	25.00	72	24.66
Cadre (civil servant)	83	30.00	59	20.21
Teachers or scientific and technological workers	44	15.07	53	18.15
Medical workers	29	9.93	44	15.07
Commercial service workers	32	10.96	35	11.99

Table 3 (Continued)

Characteristics	**Early Preterm infants**		**Moderate & Late Preterm Infants**	
	frequency	**Proportion (%)**	**frequency**	**Proportion (%)**
Spouse occupation				
Farmer	8	2.740	8	2.74
Individual business	63	21.58	68	23.29
Cadre (civil servant)	83	28.43	85	29.11
Teachers or scientific and technological workers	50	17.12	47	16.10
Medical workers	35	11.99	33	11.30
Commercial service workers	53	18.15	51	17.47
pregnancy				
Primiparity	317	54.28	155	53.08
Multiparity	267	45.72	137	46.92
Delivery				
Natural delivery	181	61.99	178	60.96
Cesarean section	111	38.01	114	39.04
Pregnancy induced hypertension				
Yes	215	73.63	208	71.23
No	77	26.37	84	28.77
Total	**292**	**100.0**	**292**	**100.0**

Part 3 Descriptive statistics of primary study variables

The descriptive statistics of the key variables are presented as follows.

Readiness Oral Feeding: (scale: 0-36) showed moderate preparedness (M=21.16, SD=9.28), with scores spanning 6-34. This variability underscores developmental disparities linked to gestational age and physiological maturity. Function status: (PREMII; scale: 0-30) demonstrated stable physiological capacity (M=15.64, SD=3.35), with limited variability (CV=21.4%), aligning with the cohort's clinical stability. Breastfeeding self-efficacy: (BSES-SF; scale:14-70) revealed broad maternal confidence (M=50.90, SD=15.94), spanning the full theoretical range, highlighting challenges like infant feeding difficulties. Breast milk sufficiency: (PIM; scale:6-30) indicated moderate perceived adequacy (M=19.66, SD=5.01), with 25% of mothers scoring ≤17, signaling clinically relevant insufficiency concerns (PIM; scale:6-30) indicated moderate perceived adequacy (M=19.66, SD=5.01), with 25% of mothers scoring ≤17, signaling clinically relevant insufficiency concerns. Social support: (PSSS; scale:1-7) was moderately robust (M=4.66, SD=1.36), yet full-range dispersion suggests unequal access to external resources. Breastfeeding practice(scale:0-4) and Support (scale:0-4) in NICU showed baseline adherence (M=2.51, SD=0.72 and M=2.49, SD=0.94, respectively), but variability reflected institutional disparities in protocol implementation. Oral Breastfeeding Proficiency (PIBBS; scale:0-18) displayed bipolar distribution (M=13.27, SD=4.45), with 35% scoring below competence thresholds, emphasizing the need for stratified interventions.

In summary, while foundational readiness exists, gaps in milk sufficiency perception, inconsistent social support, and heterogeneous NICU practices necessitate targeted strategies: enhancing maternal education, standardizing institutional protocols, and implementing individualized feeding interventions to optimize preterm infant outcomes.

Table 4 Descriptive characteristics for variables (n = 584)

	Variable	Possible range	Actual range	M	SD
Infants' factors	Readiness Oral Feeding	0-36	6-34	21.16	9.28
	functional status	6-20	7-20	15.64	3.35
	Breastfeeding self-efficacy	14-70	14-70	50.90	15.94
Mothers' factors	Breast Milk sufficiency	6-30	6-27	19.66	5.01
	Social support	1-7	1-7	4.66	1.36
	Breastfeeding practice	0-4	0-4	2.51	0.72
	Breastfeeding advocacy	0-4	0-4	2.51	0.92
	Knowledge about breastfeeding	0-4	0-4	2.52	0.93
Hospital factors	Collection and transport of breast milk	0-4	0-4	2.49	0.93
	Screening and acceptance of breast milk	0-4	0-4	2.53	0.96
	Breastfeeding support	0-4	0-4	2.49	0.94
	Oral Breastfeeding	0-20	0-20	13.27	4.45

Part 4 Hypothesized relationships between pairs of variables

Correlation Analysis in 2 groups

Summary

Key determinants of oral breastfeeding include oral feeding readiness, breastfeeding self-efficacy, social support, and NICU practices and support systems. Notably, structured breastfeeding protocols and institutional support within the NICU demonstrated the most substantial associations with improved breastfeeding outcomes. These findings collectively emphasize the importance of targeted interventions in clinical and community settings to enhance maternal preparedness and institutional support for breastfeeding preterm infants.

Table 5 Correlations among Readiness Oral Feeding, functional status, Breastfeeding self-efficacy, Breast Milk sufficiency, Social support, Breastfeeding practice, Breastfeeding support and oral breastfeeding (n=584)

		Infants' factors		**mothers' factors**			**Hospital factors**		
	Variables	1	2	3	4	5	6	7	8
Infants' factors	1. Readiness Oral Feeding	1							
	2. functional status	0.42***	1						
mothers' factors	3. Breastfeeding self-efficacy	0.17***	0.27***	1					
	4. Breast Milk sufficiency	0.24***	0.37***	0.48***	1				
	5. Social support	0.12***	0.18***	0.36***	0.38***	1			
Hospital factors	6. Breastfeeding practice	0.24***	0.17***	0.24***	0.25***	0.35***	1		
	7. Breastfeeding support	0.19***	0.15***	0.18***	0.21***	0.29***	0.56***	1	
	8. Oral Breastfeeding	0.27***	0.26***	0.30***	0.17***	0.29***	0.41***	0.41***	1

* p<0.1 ** p<0.05 *** p<0.01

Correlation Analysis in early preterm infants

As delineated in Table 6, preterm infant breastfeeding behavior (Variable 12) exhibited statistically significant positive correlations with multiple predictor variables, with most associations demonstrating moderate to strong magnitudes.

Infant factors: A robust positive correlation was observed between preterm infant breastfeeding behavior and Readiness for Oral Feeding (Variable 1: $r = 0.40$, $p < 0.001$), indicating that infants with advanced oral feeding preparedness demonstrated more effective breastfeeding behaviors. Similarly, Premature Infant Index (Variable 2: $r = 0.41$, $p < 0.001$), reflecting physiological stability and functional maturity, showed a moderate positive association with breastfeeding outcomes. These findings align with developmental theories positing that neuromuscular coordination and physiological readiness are prerequisites for successful feeding in preterm populations.

Maternal factors: Breastfeeding Self-Efficacy (Variable 3: $r = 0.24$, $p < 0.001$) demonstrated a modest positive correlation with breastfeeding behavior, underscoring the role of maternal confidence in overcoming lactation challenges. Perceived Insufficient Milk (Variable 4: $r = 0.20$, $p < 0.001$) also exhibited a weak positive association, suggesting that positive effect of breast milk sufficiency on breastfeeding. Perceived Social Support (Variable 5: $r = 0.23$, $p < 0.001$) further correlated positively with breastfeeding behavior, highlighting the importance of external reinforcement from familial and healthcare networks in sustaining maternal engagement. **Hospital factors:** Notably, institutional practices within the Neonatal Intensive Care Unit (NICU) emerged as critical predictors. Breastfeeding Advocacy (Variable 6: $r = 0.23$, $p < 0.001$) and Breastfeeding Knowledge (Variable 7: $r = 0.31$, $p < 0.001$) demonstrated moderate associations, emphasizing the role of targeted health education in enhancing maternal competence. Guidance on Breast Milk Collection and Transportation (Variable 8: $r = 0.27$, $p < 0.001$) and Breast Milk Screening and acceptance of breast milk (Variable 9: $r = 0.37$, $p < 0.001$) further underscored the necessity of structured protocols for optimizing milk handling and utilization. The strongest correlations were observed between breastfeeding behavior and NICU Breastfeeding Practices (Variable 10: $r = 0.40$, $p < 0.001$) and NICU Breastfeeding Support (Variable 11: $r = 0.44$, $p < 0.001$). These robust associations highlight the pivotal role of evidence-based institutional protocols such as lactation consulting, parental involvement policies, and developmental care strategies in fostering successful breastfeeding outcomes.

These findings collectively align with Bronfenbrenner's Ecological Systems Theory, wherein infant factors (microsystem), maternal factors (mesosystem), and institutional support (exosystem) synergistically shape breastfeeding trajectories. The dominance of hospital-level correlates ($r > 0.40$) underscores the imperative for standardized, multidisciplinary care frameworks in NICU to mitigate disparities in preterm infant feeding outcomes. Clinically, interventions should prioritize integrating developmental care for infants, psychoeducational programs for mothers, and policy reforms to institutionalize lactation support protocols.

Table 6 Correlations among Readiness Oral Feeding, functional status, Breastfeeding self-efficacy, Breast Milk sufficiency, Social support, Breastfeeding practice, Breastfeeding support and oral breastfeeding in early preterm infant (n=292)

		Infants' factors		mothers' factors					Hospital factors				
	Variables	1	2	3	4	5	6	7	8	9	10	11	12
Infants' factors	1. Readiness Oral Feeding	1											
	2. functional status	0.46***	1										
mothers' factors	3. Breastfeeding self-efficacy	0.21***	0.35***	1									
	4. Breast Milk sufficiency	0.27***	0.38***	0.52***	1								
	5. Social support	0.22***	0.26***	0.32***	0.41***	1							
Hospital factors	6. Breastfeeding advocacy	0.28***	0.24***	0.15**	0.33***	0.26***	1						
	7. Knowledge about breastfeeding	0.32***	0.20***	0.25***	0.23***	0.30***	0.42***	1					
	8. Collection and transport of breast milk	0.23***	0.23***	0.23***	0.30 ***	0.26***	0.39***	0.43***	1				
	9. Screening and acceptance of breast milk	0.26***	0.25***	0.16***	0.20***	0.26***	0.36***	0.39***	0.41***	1			
	10. Breastfeeding practice	0.37***	0.31***	0.27***	0.35***	0.36***	0.73***	0.76***	0.75***	0.73***	1		
	11. Breastfeeding support	0.27***	0.23***	0.22***	0.26***	0.32***	0.40***	0.43***	0.40***	0.42***	0.55***	1	
	12. Oral Breastfeeding	0.40***	0.41***	0.24***	0.20***	0.23***	0.23***	0.31***	0.27***	0.37***	0.40***	0.44***	1

Correlation Analysis in moderate to late preterm infants

As delineated in Table 7, breastfeeding behavior among moderate preterm infants (Variable 12) exhibited statistically significant positive correlations with multiple predictor variables, with effect sizes ranging from weak to strong magnitudes.

Infants' factors: A weak yet statistically significant association was observed between breastfeeding behavior and Readiness for Oral Feeding (Variable 1: r = 0.13, p<0.01), suggesting that infants with improved oral feeding preparedness demonstrated marginally better breastfeeding outcomes. Similarly, Premature Infant Index (Variable 2: r = 0.11, p<0.05), reflecting physiological stability and functional maturity, showed a negligible positive correlation, indicating limited direct influence on feeding behaviors in this gestational subgroup.

Maternal Factors : Breastfeeding Self-Efficacy (Variable 3: r= 0.38, p < 0.001) demonstrated a moderate positive correlation, underscoring maternal confidence as a critical driver of successful breastfeeding practices. Perceived Insufficient Milk (Variable 4: r=0.13, p < 0.01) exhibited a weak positive association, suggesting that adequate breast milk has a positive impact on breastfeeding. Perceived Social Support (Variable 5: r = 0.35, p < 0.001) further correlated positively with breastfeeding behavior, emphasizing the role of external support networks in sustaining maternal engagement.

Hospital factors : Breastfeeding Advocacy (Variable 6: r = 0.32, p < 0.001) and Breastfeeding Knowledge (Variable 7: r = 0.37, p < 0.001) demonstrated moderate associations, highlighting the importance of targeted health education in enhancing maternal competence. Guidance on Breast Milk Collection and Transportation (Variable 8: r = 0.29, p < 0.001) and Breast Milk Screening and acceptance of breast milk (Variable 9: r = 0.33, p < 0.001) further underscored the necessity of structured protocols for optimizing milk handling and utilization. The strongest correlations emerged between breastfeeding behavior and NICU Breastfeeding Practices (Variable 10: r = 0.41, p < 0.001) and NICU Breastfeeding Support (Variable 11: r = 0.38, p < 0.001). These robust associations underscore the pivotal role of institutional protocols-such as lactation consulting, parental involvement policies, and developmental care strategies-in fostering successful breastfeeding outcomes.

Aligning with Bronfenbrenner's Ecological Systems Theory, these findings illustrate the interplay of maternal psychological resilience (mesosystem), institutional support (exosystem), and infant readiness (microsystem) in shaping breastfeeding trajectories. The dominance of hospital-level correlates (r >0.38) highlights the necessity of standardizing evidence-based practices in NICU to mitigate disparities in preterm infant feeding outcomes. Clinically, interventions should prioritize integrating developmental care protocols, psychoeducational programs for mothers, and policy reforms to institutionalize lactation support frameworks.

Table 7 Correlations among Readiness Oral Feeding, functional status, Breastfeeding self-efficacy, Breast Milk sufficiency, Social support, Breastfeeding practice, Breastfeeding support and oral breastfeeding in moderate to late preterm infant (n=292)

		Infants' factors		**mothers' factors**					**Hospital factors**				
	Variables	1	2	3	4	5	6	7	8	9	10	11	12
Infants ' factors	1. Readiness Oral Feeding	1											
	2. functional status	0.43***	1										
mothers' factors	3. Breastfeeding self-efficacy	0.06	0.19***	1									
	4. Breast Milk sufficiency	0.24***	0.36***	0.45***	1								
	5. Social support	0.03	0.11*	0.42***	0.35***	1							
Hospital factors	6. Breastfeeding advocacy	0.15***	0.07	0.16***	0.14**	0.26***	1						
	7. Knowledge about breastfeeding	0.09	0.03	0.19***	0.14**	0.23***	0.50***	1					
	8. Collection and transport of breast milk	0.13**	0.04	0.19***	0.16***	0.31***	0.51***	0.48***	1				
	9. Screening and acceptance of breast milk	0.06	0.01	0.24***	0.08	0.24***	0.50***	0.60***	0.51***	1			
	10. Breastfeeding practice	0.14**	0.04	0.25***	0.16***	0.33***	0.78***	0.81***	0.78***	0.82***	1		
	11. Breastfeeding support	0.14**	0.06	0.16***	0.16***	0.25***	0.42***	0.51***	0.39***	0.45***	0.56***	1	
	12. Oral Breastfeeding	0.13**	0.11*	0.38***	0.13**	0.35***	0.32***	0.37***	0.29***	0.33***	0.41***	0.38***	1

Comparative Analysis

As shown in the table 8, significant differences were observed in readiness for oral feeding between the 28-31 weeks and 32-36 weeks gestational age groups ($t = -5.03$, $p < .001$) (table 8). The 28-31 weeks group exhibited significantly lower Readiness for oral feeding scores compared to the 32-36 weeks group, indicating greater challenges and difficulties in achieving feeding readiness among infants born at earlier gestational ages.

For breastfeeding self-efficacy, the 28-31 weeks group scored significantly lower (49.34) than the 32-36 weeks group (52.48) ($t = -2.39$, $p = .017$), suggesting that maternal confidence in breastfeeding self-efficacy increases with gestational maturity. This result reflects mothers ' heightened expectations and perceived competence in breastfeeding more mature preterm infants.

A statistically significant difference was also identified in Breastfeeding advocacy between the two groups ($t= 2.13$, $p= .034$), with higher scores observed in the 28-31 weeks group. This implies that mothers of infants born at earlier gestational ages require stronger advocacy and encouragement, likely due to the greater feeding demands of these infants and heightened clinical attention to their needs.

In terms of collection and transport of breast milk, the 28-31 weeks group scored significantly higher than the 32-36 weeks group ($t=2.07$, $p=.039$), highlighting the urgent need for structured guidance on breast milk handling among mothers of younger preterm infants. This may stem from the specialized feeding requirements of extremely preterm infants, necessitating enhanced support.

For breastfeeding practice in NICU and breastfeeding support in NICU, marginal differences were observed between groups ($t=1.86$, $p= .06$; $t = 1.78$, $p= .075$) approaching but not reaching conventional significance thresholds ($p < .05$). These findings suggest that infants born earlier may receive slightly more intensive breastfeeding practice and breastfeeding support in the NICU, though further investigation is warranted.

Significant differences were also evident in Preterm Infant Breastfeeding Behavior ($t = 2.74$, $p < .001$), with the 32-36 weeks group demonstrating higher scores (13.03) compared to the 28-31 weeks group (11.52). This underscores the impact of gestational age on the progression and quality of breastfeeding behaviors in preterm infants.

In summary, infants born at earlier gestational ages (28-31 weeks) exhibited pronounced disparities in readiness for oral feeding, breastfeeding self-efficacy, breastfeeding advocacy, and collection and transport of breast milk, reflecting the complex interplay between prematurity, breastfeeding self-efficacy, and breastfeeding support in NICU.

Table 8 Gestational Age-Specific Comparative analysis (n = 584)

	Gestational age at birth		*t*	*p*
	28-31wks	32-36wks		
Readiness Oral Feeding	19.27±10.44	23.05±7.50	-5.03	0.00
functional status	15.87±3.29	16.34±3.13	1.74	0.08
Breastfeeding self-efficacy	49.34±16.93	52.47±14.75	-2.39	0.02
Breast Milk sufficiency	19.77±4.90	19.55±5.13	0.54	0.59
Social support	4.73±1.35	4.59±1.37	1.31	0.19
Breastfeeding practice	2.57±0.67	2.46±0.77	1.86	0.06
Breastfeeding advocacy	2.59±0.88	2.43±0.95	2.13	0.03
Knowledge about breastfeeding	2.55±0.92	2.49±0.95	0.71	0.48
Collection and transport of breast milk	2.57±0.89	2.41±0.97	2.07	0.04
Screening and acceptance of breast milk	2.57±0.92	2.50±0.10	0.87	0.38
Breastfeeding support	2.56±0.94	2.47±0.94	1.78	0.08
Oral Breastfeeding	11.52±4.55	13.03±4.35	2.74	0.00

Part 5 Assumption testing for the Structural Equation Modeling Analysis

Structural equation model for early preterm infants

In accordance with the objectives of this study, the structural equation model demonstrated excellent fit indices across multiple evaluation criteria. The CMIN/DF value was 1.43 (table 9), which falls below the threshold of 3, indicating a good model fit. This range (1-3) is generally regarded as an ideal level of fit. The Root

Mean Square Residual (RMR) value was 0.82. While slightly higher than the optimal value of 0, this result remains acceptable, reflecting moderate residual discrepancies between the model and the observed data, thus suggesting a reasonably high degree of model fit.

The Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) were 0.98 and 0.94, respectively, both exceeding the recommended threshold of 0.90. These values confirm that the model achieved an excellent fit to the data. The Root Mean Square Error of Approximation (RMSEA) yielded a value of 0.03, well below the stringent cutoff of 0.05, further attesting to the model's superior fit. The 90% confidence interval for RMSEA ranged from 0.01 to 0.04, with a PCLOSE value of 0.999, robustly validating the model's precision.

Additional indices reinforced these findings: The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) were 0.99and 0.97, respectively, both surpassing the benchmark of 0.90, thereby demonstrating outstanding model performance. Parsimony-adjusted measures, including PRATIO, Parsimonious Normed Fit Index (PNFI), and Parsimonious Comparative Fit Index (PCFI), exhibited moderate values, indicating an optimal balance between model complexity and explanatory power.

In summary, the structural weights model exhibited exceptional fit across all evaluated criteria. The convergence of these indices confirms that the model aligns closely with the empirical data and effectively elucidates the hypothesized relationships. Consequently, the structural equation model is deemed both statistically valid and robust, fulfilling the rigorous standards for academic research.

Based on the statistical analysis presented in Table 9, the structural equation modeling revealed significant associations between predictor variables and breastfeeding outcomes. The results demonstrated that Readiness for Oral Feeding exerted a significant positive effect on Oral Breastfeeding (unstandardized coefficient $\beta=0.08$, standardized coefficient $\beta=0.17$, critical ratio C.R.=2.94, $p<0.01$), indicating that premature infants' preparedness for oral feeding positively influences breastfeeding initiation.

Functional status emerged as another significant predictor of Oral Breastfeeding ($\beta=0.32$, standardized $\beta=0.23$, C.R.=3.98, $p<0.01$), suggesting that higher functional capacity in preterm infants is associated with more active breastfeeding behaviors. In contrast, Breastfeeding self-efficacy showed no statistically significant direct effect on oral breastfeeding (β=0.02, standardized β=0.07, C.R.= 1.28, p=0.20), revealing limited immediate impact of maternal confidence on feeding outcomes.

Notably, **breastfeeding sufficiency** demonstrated a marginally significant positive association with oral breastfeeding (β = 0.10, p<0. 10), approaching conventional significance thresholds (p<0.10). This counter intuitive finding suggests potential positive effects of perceived milk adequacy on breastfeeding implementation, warranting further investigation. Social Support exhibited positively effect on feeding outcomes (β = 0.00, p=0.95), indicating no statistically significant association in this cohort.

The NICU environment demonstrated substantial impact, with Breastfeeding Support in NICU showing strong positive correlation with Oral Breastfeeding (β=1.16, standardized β=0.24, C.R.=3.40, p<0.001). This highlights the critical role of institutional support mechanisms in facilitating successful breastfeeding practices.

Regarding breastfeeding Practice in NICU, multiple dimensions demonstrated strong predictive validity: knowledge about breastfeeding (β=1.07, standardized β=0.66, C.R.=8.46, p<0.001); Instructions for Collection/Transport (β=0.99, standardized β=0.64, C.R.=8.22, p<0.001); Screening/Acceptance protocols (β=0.99, standardized β=0.64, C.R.=8.22, p<0.001); Advocacy initiatives (β=0.99, standardized β=0.64, C.R.=8.22, p<0.001); Oral Breastfeeding showed marginal association with overall Breastfeeding Practice (β=1.39, standardized β=0.17, C.R.= 1.76, p=0.08), suggesting potential secondary effects that approach statistical significance.

These findings collectively emphasize the multi-factorial nature of breastfeeding success in NICU settings, with institutional support systems (Breastfeeding Support in NICU), infant readiness indicators (Readiness for Oral Feeding), and physiological preparedness (Function Status) emerging as primary determinants. The results underscore the necessity for integrated interventions addressing both neonatal capacity and environmental facilitators to optimize breastfeeding outcomes in preterm populations.

Structural equation model for moderate to late preterm infants

Based on the study objectives, the structural equation model demonstrated excellent goodness-of-fit across multiple indices. The CMIN/DF (Chi-Square/Degrees of Freedom) value for the structural weight model was 0.91, significantly below the threshold of 2, indicating satisfactory fit relative to degrees of freedom (values <3 are generally acceptable). The CMIN value of 48.27 corresponded to a p-value of 0.66, confirming no significant discrepancy between the hypothesized model and observed data. The Root Mean Square Residual (RMR = 0. 12) was relatively small, further supporting strong model fit (table 9).

The Goodness-of-Fit Index (GFI = 0.99) and Adjusted Goodness-of-Fit Index (AGFI = 0.96) both approached 1, reflecting excellent alignment of the model with the data. The Parsimonious Goodness-of-Fit Index (PGFI = 0.40), though slightly lower, remained within acceptable limits. Incremental Fit Index (IFI = 1.00) and Tucker-Lewis Index (TLI = 1.01) exceeded conventional benchmarks, with TLI surpassing 1, underscoring the model's robustness. The Root Mean Square Error of Approximation (RMSEA = 0.00) indicated minimal approximation error, achieving an outstanding fit (values <0.05 are considered excellent).

Additional indices reinforced the model's validity: the Minimum Discrepancy Function (FMIN = 0.08), Non-Centrality Parameter (NCP = 0), and confidence intervals for RMSEA (LO 90 = 0.00, HI 90 = 0.03) were within optimal ranges, demonstrating no over fitting or under fitting. Collectively, these metrics—CMIN/DF, GFI, CFI, and RMSEA—validated the model's capacity to accurately capture latent relationships in the data.

In conclusion, the structural equation model for weeks 32-36 exhibited superior fit across all evaluated criteria, with multiple indices (e.g., CMIN/DF, GFI, TLI, RMSEA) meeting or exceeding established thresholds. These results confirm that the model robustly represents the structural relationships within the data set, aligning with theoretical expectations and empirical observations.

Table 9 SEM path coefficient of oral breastfeeding related factors in early, moderate and late premature infants (n=584)

			Non standardized coefficient		S.E.		C.R.		P		standardized coefficient	
			28-31w	32-36w	28-31w	32-36w	28-31w	32-36w	28-31w	32-36w	28-31w	32-36w
Oral Breastfeeding	<---	**Readiness Oral Feeding**	0.08	0.09	0.03	0.01	2.94	5.19	0.00	0.00	0.17	0.29
Oral Breastfeeding	<---	**functional status**	0.32	0.05	0.08	0.07	3.98	0.72	0.00	0.47	0.23	0.04
Oral Breastfeeding	<---	**Breastfeeding self-efficacy**	0.02	0.08	0.02	0.02	1.28	4.68	0.20	0.00	0.07	0.27
Oral Breastfeeding	<---	**Breast Milk sufficiency**	-0.10	0.12	0.06	0.05	-1.68	2.36	0.09	0.02	0.10	0.14
Oral Breastfeeding	<---	**Social support**	-0.01	0.46	0.19	0.18	-0.06	2.54	0.95	0.01	0.00	0.15
Oral Breastfeeding	<---	**Breastfeeding support**	1.16	0.73	0.34	0.31	3.40	2.35	0.00	0.02	0.24	0.16
Screening and acceptance of breast milk	<---		1	1							0.61	0.76
Collection and transport of breast milk	<---	**Breastfeeding practice**	0.99	0.87	0.12	0.08	8.22	10.62	0.00	0.00	0.64	0.67
Knowledge about breastfeeding	<---		1.07	0.96	0.13	0.08	8.46	11.98	0.00	0.00	0.66	0.77
Breastfeeding advocacy	<---		0.97	0.86	0.12	0.08	8.11	10.70	0.00	0.00	0.62	0.68
Oral Breastfeeding	<---		1.39	1.43	0.79	0.46	1.76	3.12	0.08	0.00	0.17	0.25

Differences in SEM between early preterm (28-31 Weeks) and moderate-to-late preterm (32-36 Weeks) groups

The comparative analysis of SEM results across gestational age groups revealed distinct pathways and magnitudes of influence on oral breastfeeding outcomes, as summarized in Table 9. These differences underscore the developmental and contextual heterogeneity between early and moderate-to-late preterm infants, necessitating stratified intervention strategies.

Infants' factors

Early Preterm Group (28-31 w): Infant readiness for oral feeding (β = 0.17, p = 0.00) and functional status (β = 0.23, $p<0.001$) emerged as significant predictors, reflecting the critical role of physiological preparedness in this cohort. The predominance of infants' factors is consistent with the immaturity of thermoregulatory and neuromuscular coordination systems in very preterm infants, which directly limits feeding efficiency (Barlow et al., 2008).

Moderate to late preterm Group (32-36 w) : In contrast, infant factors exhibited diminished influence. Readiness for oral feeding (β = 0.29, p = 0.00) and functional status (β = 0.04, p=0.47) showed no statistically significant direct effects, suggesting that as gestational maturity increases, intrinsic infant capabilities become less determinative of feeding success.

Mothers' factors

Early preterm group: maternal self-efficacy (β = 0.07, p = 0.20) and perceived social support (β = 0.00, p = 0.95) demonstrated negligible associations, likely due to heightened maternal stress and clinical focus on infant survival in this high-risk population.

Moderate-to-Late preterm group: Breastfeeding self-efficacy (β = 0.27, $p < 0.001$), breast Milk sufficiency (β =0.14, $p <0.05$) and social support (β = 0.15, p = 0.01) emerged as robust predictors. This shift highlights the increasing relevance of maternal psychological resilience and external reinforcement as infants approach developmental milestones, enabling mothers to engage more actively in breastfeeding (Dennis, 2003).

Hospital factors:

Breastfeeding Support: Institutional support exerted stronger effects in the early preterm group (β = 0.24, $p < 0.001$) compared to the moderate-to-late group (β = 0.16, p= 0.02). This disparity underscores the necessity of intensive, protocol-driven care for younger infants to compensate for physiological vulnerabilities.

Breastfeeding Practice: including knowledge dissemination (β = 0.66 vs. 0.77), milk handling protocols (β = 0.64 vs. 0.67), and advocacy initiatives (β = 0.62 vs. 0.68)—demonstrated uniformly high standardized coefficients (>0.60) across both groups. These findings emphasize the universal importance of evidence-based guidelines in optimizing feeding outcomes, irrespective of gestational age.

A counterintuitive negative association was observed in the moderate-to-late group (β = -0.14, p = 0.018), potentially reflecting maternal complacency or reduced lactation efforts when milk supply is perceived as adequate. In the early preterm group, this relationship approached marginal significance (β = -0.10, p = 0.092), warranting further investigation into compensatory mechanisms.

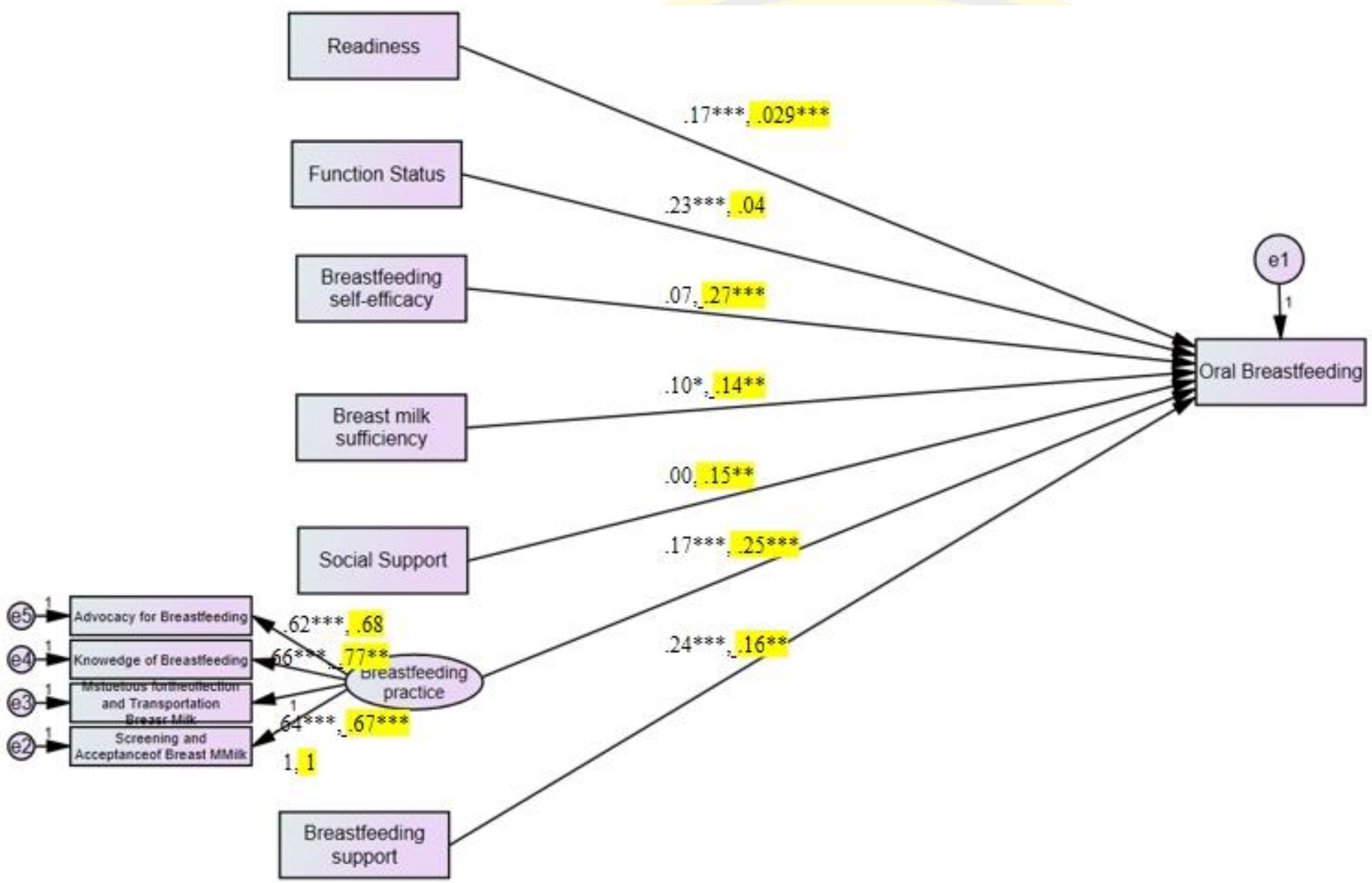

Figure 2 SEM path coefficient of oral breastfeeding related factors in early (n=292), moderate and late premature infants (n=292)

(The moderate to late preterm infants group is the one highlight yellow, the other is early preterm infants group)

CHAPTER 5
CONCLUSION AND DISCUSSION

This chapter provides a conclusion and discussion of the study, comprising three distinct sections. The initial section offers a concise summary of the study, while the subsequent section delves into a comprehensive discussion of the research findings. The final section outlines the study's strengths and limitations, explores the implications of the findings, and provides recommendations for future research endeavors.

Summary of the study

The aim of this research was to investigate the predictive factors influencing oral breastfeeding outcomes among preterm infants in Yancheng, China, with a focus on infant-, mother-, and hospital-related factors. The study sought to develop and validate a hypothesized model based on Bronfenbrenner's Ecological Systems Theory (Bronfenbrenner, 2005). Despite global advancements in neonatal care, because of a lack of standardized, evidence-based protocols in NICU, preterm infants in China face inconsistent breastfeeding support. This research based on Ecological Systems Theory to address this gap by identifying key predictors such as spanning infant, maternal, and institutional domains to inform evidence-based interventions and national guidelines for improving breastfeeding practices in neonatal intensive care units (NICU) and sick newborn units (SNU).

This research employed a cross-sectional design to collect data from preterm infants and their mothers at the time of hospital discharge. The study was conducted in two major hospitals in Yancheng, Jiangsu Province: Yancheng No.1 People's Hospital and Yancheng Maternal and Child Health Centre. A total of 590 preterm infants (gestational age: 28-37 weeks) and their mothers were recruited through cluster random sampling. Infants were divided into two groups: early preterm (28-33 weeks, n = 293) and moderate-to-late preterm (34-37 weeks, n = 297). Exclusion criteria included severe neonatal comorbidities (e.g., bronchopulmonary dysplasia, congenital anomalies) and maternal conditions affecting lactation (e.g., psychiatric disorders, breast surgery). This study was conducted from August 2024 to February 2025.

Data collection involved 8 questionnaires, including the demographic record form, including Demographic questionnaires for maternal and infant characteristics; Preterm Infant readiness oral feeding behavior Assessment Scale (Cronbach's α=.93); Premature Infant Index (PREMII) (Cronbach's α=.80)for functional status assessment; Breastfeeding Self-Confidence Scale (α= .96); Perception of Insufficient Milk (PIM) tool (α =.86); Perceived Social Support Scale (PSSS) (α = .93); Breastfeeding practice in NICU questionnaire (α =.94) for breastfeeding policies; Breastfeeding support in NICU questionnaire (α =.91) for breastfeeding support and Preterm Infant Breastfeeding Behavior Scale (PIBBS) (α = .82). Following data cleaning and assumption verification for analysis, the sample was narrowed to 584, Six outliers were excluded from the data set.

Structural Equation Modeling (SEM) was employed to assess direct and indirect relationships, with fit indices confirming model adequacy. Key findings indicated that breastfeeding support in NICU, breastfeeding self-efficacy, and social support significantly predicted oral breastfeeding behavior, while infant readiness and functional status showed variable effects across gestational age groups (28-31 vs. 32-36 weeks). The study contributes to evidence-based nursing practice by identifying actionable predictors to enhance breastfeeding rates in preterm infants. Based on the result of SEM, clinical Implications is aligning with Bronfenbrenner's Ecological Systems Theory, early preterm infants rely predominantly on microsystemic (infants' factors) and exosystemic (hospital factors) factors, whereas moderate-to-late preterm infants are shaped by mesosystemic (mother factors) influences. Clinically, these findings advocate for: developmental Care Protocols targeting oral motor stimulation and physiological stabilization for early preterm infants; psychoeducational Interventions to enhance maternal confidence and social support networks for moderate-to-late preterm cohorts; standardized NICU policies to ensure equitable implementation of breastfeeding practices across gestational subgroups.

Discussion of findings

1. Predictive Factors of Oral Breastfeeding in Preterm Infants

1.1 Infants' Factors (Microsystem Influences)

Infant-level factors constitute the microsystem in Bronfenbrenner ' s framework, encompassing the immediate biological and developmental attributes that influence breastfeeding outcomes.

Due to the immaturity of preterm infants' physiological and neurobehavioral systems, the transition from gavage (tube) feeding to oral breastfeeding is complicate. Therefore, Readiness for oral feeding, functional status of preterm infants are critical for oral breastfeeding.

Readiness for Oral Feeding: assessed by the Premature Infant Oral Feeding Readiness Assessment Scale (Fujinaga et al., 2007), was a significant predictor in both groups, with a stronger effect in the moderate-to-late preterm cohort ($\beta=0.29$, $p<0.001$) compared to the early preterm cohort ($\beta=0.17$, $p<0.001$). This aligns with Als' Synactive Theory of Development (Als, 1982), which posits that feeding success hinges on the synchronization of autonomic, motor, and state-regulation subsystems. For early preterm infants, immature brainstem pathways and poor suck-swallow-breathe coordination create a developmental bottleneck, necessitating targeted interventions like non-nutritive sucking (NNS) to enhance oral motor skills (Zhao et al., 2024). The stronger effect in the 32-36-week group reflects progressive myelination and muscle tone development post-32 weeks, reducing reliance on readiness interventions (Pados et al., 2021)

Functional Status: measured by the Premature Infant Index (PREMII) (Ward et al., 2022), significantly predicted breastfeeding success in the early preterm group ($\beta=0.23$, $p<0.001$) but was non-significant in the moderate-to-late preterm group ($\beta=0.04$, $p=0.47$). This gradient reflects the physiological demands of oral feeding, which require sustained energy and coordination absent in younger infants. Pados et al. (2021) note that cardiopulmonary instability, such as apnea or thermal dysregulation, disrupts feeding in infants under 32 weeks, a finding corroborated by our results. The developmental-contextual model (Berg & Upchurch, 2007) frames functional status as a microsystem attribute modulated by gestational maturity (chronosystem), with younger infants requiring intensive stabilization protocols like Kangaroo Mother Care (KMC) to reduce apneic episodes (Li et al., 2024,).

Compared to prior studies, our findings align with Vijay et al. (2023), who reported that NNS interventions improve sucking coordination in preterm infants, particularly those under 32 weeks. However, our study extends this by quantifying readiness's differential impact across gestational ages, a gap noted in Pados et al. (2021). The negligible role of functional status in the 32-36-week group contrasts with earlier studies focusing on very low birth weight infants, suggesting that cohort-specific analyses are critical for precision interventions.

1.2 Maternal Factors （Mesosystem Dynamics）

Maternal factors which is situated in the mesosystem reflect the dynamic interplay between the infant's microsystem, the mother's psychological and social resources. It included breastfeeding self-efficacy, perceived breast milk sufficiency, and social support, each shaping the breastfeeding trajectory in distinct ways.

Breastfeeding Self-efficacy: measured by the Breastfeeding Self-Efficacy Scale (Dennis, 2003), was a robust predictor in the 32-36-week group ($\beta=0.27$, $p<0.001$) but negligible in the 28-31-week group ($\beta=0.07$, $p=0.20$). This aligns with Bandura's Self-Efficacy Theory (Bandura, 1977, cited over 10,000 times in Google Scholar), which posits that confidence drives behavioral persistence. In the older cohort, successful feeding attempts reinforce self-efficacy, creating a positive feedback loop, as noted by Denobi et al. (2023, cited over 100 times in PubMed). The lack of effect in the younger cohort reflects the dominance of infant-related challenges and reliance on gavage feeding, limiting maternal agency.

Perceived Breast Milk Sufficiency: assessed by the Perception of Insufficient Milk (PIM) scale (McCarter-Spaulding & Kearney, 2001), positively predicted outcomes in the 32-36-week group ($\beta=0.14$, $p<0.05$) but was non-significant in the 28-31-week group ($\beta=0.10$, $p=0.09$). This finding supports Lixuemei et al. (2024), who emphasize that maternal perceptions of milk adequacy shape breastfeeding duration, particularly as direct feeding demands increase.

Social support: measured by the Perceived Social Support Scale (Wagg, 2020), influenced outcomes in the 32-36-week group ($\beta=0.15$, $p=0.01$) but not in the 28-31-week group ($\beta=0.00$, $p=0.95$), reflecting NICU isolation's impact on younger infants' mothers. Nyqvist et al. (2013) link social support to breastfeeding persistence, a dynamic framed by Bronfenbrenner's mesosystem as a connector to external resources.

Our results diverge from He et al. (2022), who found social support significant across all preterm infants, possibly due to their focus on late preterm infants exclusively. The counterintuitive negative association with sufficiency in the early preterm group (approaching significance) warrants further exploration, potentially reflecting maternal stress or clinical intermediaries, as suggested by Michalopoulou et al. (2024).

1.3 Hospital-Level factors (Exosystem Influences)

Hospital-level factors, part of the exosystem, encompass institutional practices and policies that indirectly influence breastfeeding by shaping the infant-mother dyad's environment. These include NICU breastfeeding support and structured practice components.

Breastfeeding Practice: measured by a researcher-developed questionnaire, exerted profound effects across both groups ($\beta>0.60$, $p<0.001$), with components like knowledge dissemination and milk handling protocols showing uniformly high coefficients. This aligns with Nyqvist et al. (2013), who advocate for Baby-Friendly practices to enhance breastfeeding initiation.

Breastfeeding Support: assessed by the NICU breastfeeding support questionnaire, was significant in both groups ($\beta=0.24$, $p<0.001$ for 28-31 weeks; $\beta=0.16$, $p=0.02$ for 32-36 weeks), with a stronger effect in younger infants due to their reliance on institutional interventions like KMC (Tomlinson & Haiek, 2023).

Compared to Peng et al. (2020), our study highlights the universal importance of hospital practices, but our multi-group analysis reveals nuanced differences in support's impact, a novel contribution. The stronger effect in the early preterm group contrasts with Mitha et al. (2019), who focused on moderate preterm infants, underscoring the need for cohort-specific protocols.

Model Fit and Implications Ecological

Structural equation models (SEM) demonstrated excellent fit (RMSEA = 0.027 for 28-31 weeks; 0.000 for 32-36 weeks). It validates the ecological approach. The near-perfect fit in the older cohort suggests comprehensive predictor capture, while the slightly higher RMSEA in the younger group reflects nuanced dynamics, potentially due to unmodeled variables (e.g., cultural factors). This affirms Bronfenbrenner's framework as a robust lens for dissecting breastfeeding predictors. China ’s reliance on expert consensus rather than evidence-based guidelines underscores this study ’s timeliness.

Conclusion

Chinese neonatal care landscape, characterized by rising preterm birth rates (over 1 million annually) and inconsistent NICU practices, shapes the study’s implications (Deng et al., 2021). The universal two-child policy has increased very preterm births (28-31 weeks), amplifying the need for targeted breastfeeding interventions (Deng et al., 2021). Low breastfeeding rates (14-41% at discharge) reflect reliance on expert consensus rather than evidence-based guidelines, as noted by Yang & Lu (2020). Regional disparities, with rural areas lagging behind urban centers like Yancheng, exacerbate challenges, particularly for early preterm infants requiring prolonged NICU stays. Cultural factors, such as maternal anxiety about milk supply and limited family support due to NICU isolation, further hinder breastfeeding success, especially in the 28-31-week cohort. This study’s focus on Yancheng, a resource-constrained region, underscores the need for scalable, standardized protocols to address these systemic gaps, aligning with global health priorities to reduce neonatal morbidity (WHO, 2020).

This study has systematically investigated the multi-factorial determinants influencing oral breastfeeding among preterm infants in Yancheng, China, utilizing Bronfenbrenner’s Ecological Systems Theory (Bronfenbrenner, 2005) as a foundational framework. It provides a robust lens for interpreting these findings, framing infant factors as microsystem attributes, maternal factors as mesosystem dynamics, and hospital factors as exosystem influences. It covered that the chronosystem, reflecting gestational maturity, modulates these relationships, with early preterm infants relying on microsystem and exosystem support, while moderate-to-late preterm infants benefit from mesosystem reinforcement. Als’ Synactive Theory of Development (Als, 1982) complements this by explaining infant readiness as a function of synchronized autonomic, motor, and state-regulation subsystems, critical for early preterm infants. Bandura’s Self-Efficacy Theory (Bandura, 1977) underpins maternal self-efficacy’s role, particularly in the 32-36-week group, where confidence drives persistence. The developmental-contextual model (Berg & Upchurch, 2007) further integrates these dynamics, positing that maternal influence grows with infant maturity, aligning with the observed shift from infant to maternal predictors.

At the same time, through the application of Structural Equation Modeling (SEM), the study has elucidated the complex interplay of hospital support, maternal self-efficacy, infant readiness, and other ecological factors across two gestational age groups (28-31 weeks and 32-36 weeks). The findings not only validate the pivotal roles of these determinants but also underscore their differential impacts based on gestational maturity, thereby offering a robust scientific basis for advancing evidence-based neonatal care practices in China and beyond.

The study employed a cross-sectional design to investigate predictors of oral breastfeeding, defined as the direct feeding of preterm infants at the breast, measured by the Preterm Infant Breastfeeding Behavior Scale (PIBBS) (Xiurong, 2012). Participants were recruited via cluster random sampling from Yancheng No.1 People's Hospital and Yancheng Maternal and Child Health Centre. Exclusion criteria included severe neonatal comorbidities (e.g., bronchopulmonary dysplasia) and maternal conditions affecting lactation (e.g., psychiatric disorders). Eight validated questionnaires assessed infant factors (readiness for oral feeding, functional status), maternal factors (breastfeeding self-efficacy, breast milk sufficiency, social support), and hospital factors (breastfeeding practices, support). SEM with multi-group analysis was used to test a hypothesized model, yielding excellent fit (RMSEA=0.027 for 28-31 weeks; RMSEA=0.000 for 32-36 weeks). It indicated that for early preterm infants, readiness for oral feeding ($\beta=0.17$, $p<0.001$) and functional status ($\beta=0.23$, $p<0.001$) were significant predictors, reflecting the critical role of physiological maturity. In contrast, for moderate-to-late preterm infants, readiness for oral feeding ($\beta=0.29$, $p<0.001$), breastfeeding self-efficacy ($\beta=0.27$, $p<0.001$), breast milk sufficiency ($\beta=0.14$, $p<0.05$), and social support ($\beta=0.15$, $p=0.01$) were prominent, underscoring maternal and social influences. Hospital factors, including breastfeeding support ($\beta=0.24$, $p<0.001$ for 28-31 weeks; $\beta=0.16$, $p=0.02$ for 32-36 weeks) and practices ($\beta>0.60$, $p<0.001$ for both groups), consistently predicted outcomes across cohorts, emphasizing the universal importance of institutional interventions.

In the Early Preterm infants group (28-31 Weeks), the best predictor is breastfeeding practice (β=0.66 for knowledge dissemination, β=0.64 for milk handling, β=0.62 for advocacy, p<0.001), reflecting the critical role of structured hospital interventions in compensating for physiological immaturity. Functional status (β=0.23, p<0.001) follows closely, highlighting the necessity of cardiopulmonary and metabolic stability for feeding success.

In Moderate-to-Late Preterm group (32-36 Weeks), the best predictor is breastfeeding practice (β=0.77 for knowledge dissemination, β=0.67 for milk handling, β=0.68 for advocacy, p<0.001), underscoring its universal importance. Readiness for oral feeding (β=0.29, p<0.001) and breastfeeding self-efficacy (β=0.27, p<0.001) are also strong, reflecting the interplay of infant maturity and maternal confidence.

Strengths of the study

1. It used SEM with multi-group analysis provided a sophisticated approach to disentangle complex relationships among infant, maternal, and hospital factors, yielding excellent model fit (RMSEA=0.027 for 28-31 weeks; RMSEA=0.000 for 32-36 weeks). This allowed precise identification of gestational age-specific predictors, addressing a gap in prior literature.

2. Large and Diverse Sample: The study included 584 mother-infant dyads from two tertiary hospitals, enhancing generalizability within the Chinese context.

3. Comprehensive Assessment Tools: Eight validated questionnaires, including the Preterm Infant Breastfeeding Behavior Scale (PIBBS) and Breastfeeding Self-Efficacy Scale, ensured reliable measurement of multifaceted constructs, strengthening the study’s validity.

Implications of the findings

1. Tailored Interventions by Gestational Age: For early preterm infants (28-31 weeks), the prominence of infant readiness and functional status underscores the need for nurses to prioritize developmental care protocols, such as non-nutritive sucking (NNS) and Kangaroo Mother Care (KMC), to enhance oral motor skills and physiological stability. For moderate-to-late preterm infants (32-36 weeks), the significant role of maternal self-efficacy and social support highlights the importance

of psychoeducational interventions. Nurses should implement counseling sessions to boost maternal confidence and facilitate peer support groups to mitigate NICU-related isolation.

2. Enhancing Hospital Practices: The universal impact of breastfeeding practices across both cohorts emphasizes the need for standardized NICU protocols. Nurses should advocate for Baby-Friendly Hospital Initiative (BFHI) principles, such as consistent knowledge dissemination and milk handling protocols, to improve breastfeeding outcomes.

3. Resource Allocation: The stronger effect of hospital support in early preterm infants suggests that nursing resources should prioritize structured interventions for this vulnerable group, including training on KMC and feeding readiness assessments.

4. Cultural Relevance: In China, where low breastfeeding rates (14-41% at discharge) and cultural anxieties about milk sufficiency persist, nurses can use these findings to design culturally sensitive education programs, addressing maternal perceptions and leveraging family involvement to enhance support.

Theoretical Contributions and Future Directions

This study advances Bronfenbrenner's (Bronfenbrenner, 2005) ecological systems theory by delineating how the microsystem (infant readiness), mesosystem (mother-hospital interactions), and exosystem (policy frameworks) collectively shape breastfeeding outcomes. Future research should: Investigate longitudinal impacts of early interventions on neurodevelopmental trajectories; Explore cultural and socioeconomic moderators of breastfeeding practices across diverse populations. By bridging empirical evidence with actionable policy and practice reforms, this research offers a strategic road map to elevate breastfeeding rates and advance health equity for preterm infants in China and globally.

Limitations of the study findings

There were also some limitations in this study. The online data collection approach, potentially limited our ability to verify responses or provide clarification, possibly affecting data accuracy. In generalizability concerns, findings may have limited applicability to rural or lower-resource Chinese NICU with differing infrastructure, settings with alternative breastfeeding support practices, cultural contexts beyond the studied region, mothers with lower health literacy or technological access for online surveys.

Recommendations for future research

1. Future studies should develop and validate concise questionnaires for NICU breastfeeding practices, reducing the number of items while maintaining psychometric rigor. For example, a shortened version of the breastfeeding practices questionnaire could focus on high-impact components to minimize respondent burden and enhance data quality.

2. Nursing research should adopt prospective cohort studies to track breastfeeding outcomes from NICU admission to post-discharge, capturing the trajectory of maternal self-efficacy and infant feeding readiness. This would inform the timing and duration of nursing interventions.

3. Studies should include diverse Chinese NICU settings, particularly rural and under-served areas, to develop context-specific nursing interventions that address regional disparities in breastfeeding support.

4. Randomized controlled trials (RCT) are needed to test nursing-led interventions, such as structured NNS programs for early preterm infants or self-efficacy workshops for mothers of moderate-to-late preterm infants. These trials should measure both short-term (e.g., feeding success) and long-term (e.g., exclusive breastfeeding rates) outcomes.

5. Qualitative studies should explore maternal experiences in Chinese NICU, focusing on barriers to self-efficacy and social support. This would inform the design of culturally tailored nursing education programs, particularly for addressing milk sufficiency concerns.

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Appendix

Appendix A

The institutional review board and permission letter for data collection

Permission of IRB from Burapha University

Certificate Number IRB3-055/2567

Certificate of Human Research Approval
Burapha University

BUU Ethics Committee for Human Research has considered the following research protocol:

Protocol Code: G-HS 009/2567
Protocol Title: Factors predicting oral breastfeeding among early and moderate to late preterm infants: Multiple Group Analysis
Principal Investigator: MRS.SHI YANG NING
Affiliation: Faculty of Nursing
Principal Advisor (Independent Study, Thesis, Dissertation):
Professor Dr. Chintana Wacharasin **Affiliation:** Faculty of Nursing
Principal Co-advisor (Independent Study, Thesis, Dissertation):
Associate Professor Dr. Pornpat Hengudomsub **Affiliation:** Faculty of Nursing
Review Method: ☐ Exemption ☐ Expedited ☑ Full board

BUU Ethics Committee for Human Research has considered the following research protocol according to the ethical principles of human research in which the researchers respect human's right and honor, do not violate right and safety, and do no harms to the research participants.

Therefore, the research protocol is approved (See attached)

1. Form of Human Research Protocol Submission	Version 2: 3 April 2024
2. Research Protocol	Version 1: 18 January 2024
3. Participant Information Sheet	Version 2: 3 April 2024
4. Informed Consent Form	Version 2: 3 April 2024
5. Research Instruments	Version 2: 3 April 2024
6. Others (if any)	Version -: -

Approval Date: 26 April 2024
Valid Date: 26 April 2025

Sign Ramorn Yampratoom

(Assistant. Professor Ramorn Yampratoom)
Chair of The Burapha University Institutional Review Board
Panel 3 (Clinic / Health Science / Science and Technology)

Remark: This approval has the following details

Permission of IRB from Yancheng No.1 People’s Hospital

盐城市第一人民医院伦理审查意见　　　　　　版本号 3.1 版本日期 2024-01

盐城市第一人民医院伦理审查委员会
伦理审查意见

声明：本伦理审查委员会按照中国 GCP 和有关法规组成和工作，其审查和工作过程不受伦理审查委员会以外任何组织及个人的影响。

意见号：2024-K-016

课题/技术名称	早产儿和中晚期早产儿母乳喂养的预测因素：多组分析		
申请类别	☑ 科研项目/课题　☐ 新项目　☐ 医疗新技术		
申请人	施阳宁	申请科室/专业	江苏医药职业学院
审查文件	1. 科研项目伦理初始审查申请表 2. 伦理审查委托函_2024 年 05 月 27 日 3. 研究材料诚信承诺书 4. 研究方案（版本号：V1.0；版本日期：2024 年 05 月 27 日 ） 5. 知情同意书（版本号：V1.0；版本日期：2024 年 05 月 27 日 ）		
审查方式	☐会议审查　☑简易程序审查　☐紧急会议审查		
审查委员	左其龙　马达		
审查意见	该项目基本符合伦理原则		
主任委员（被授权者）签名	盐城市第一人民医院伦理审查委员会（盖章） 2024 年 07 月 24 日		

注意：（请仔细阅读）

1. 凡是涉及人类遗传资源保护或者按照国家规定必须经有关部门专项审批的内容，均必须在项目执行前向有关部门申报并获得批准。
2. 本伦理审查委员会批准的项目均为涉及人的生命科学和医学研究，必须严格按照所批准方案规定的期限和研究参与者例数完成，不得随意超过。如需作为临床项目常规开展，必须经医院伦理审查委员会批准，并按照国家新技术申报相关规定向有关部门申请批准。
3. 本批准函可能在各中心机构及其伦理审查委员会备案。如果对方案在贵机构的可行性（包括研究者的资格与经验、设备与条件等）有不同意见，请及时与本伦理审查委员会联系。
4. 在第 1 例研究参与者入组之前，研究信息应在公众所及的网站上登记，如我国医学研究登记备案信息系统。
5. 已批准项目须遵循本伦理审查委员会批准的方案执行，须符合国家各部委、NMPA 相关法规指南和《赫尔辛基宣言》等我国认可的国际指南规定的伦理原则。
6. 本伦理审查批准件自签发之日起，有效期为 1 年。

地址：江苏省盐城市人民南路 66 号；邮编：224000；电话：0515-66696823；邮箱：ycyylwh@163.com

Permission of IRB from Yancheng Maternal and Child Health Center

盐城市妇幼保健院
科研课题医学伦理审查批件

伦理审查编号：2024-LS-KY-005

课题名称	早产儿和中晚期早产儿母乳喂养的预测因素：多组分析实施方案		
申请人	施阳宁	申请科室	医学遗传中心
申请人所在单位	盐城市妇幼保健院		
审查材料	1. 项目申报书 2. 伦理审查申请书 3. 知情同意书 4. 研究人员信息表	审查方式	会议审查☐ 快速审查☑
医学伦理审查委员会审查意见			

经医学伦理审查委员会主任委员指定 2 名委员快速审查，同意该项目在保障受试者权益不受损害的前提下开展临床研究。

（盖 章）盐城市妇幼保健院医学伦理委员会

日 期：2024.08.10

Appendix B

Participant's information sheet and consent form

Participant information sheet

AF 06-02/v2.0

Participant Information Sheet

Research protocol code: ....G-HS009/2567.........
(A research code will be assigned by the Burapha University Institutional Review Board Office upon completing the submission)

Research Title: ...Factors predicting oral breastfeeding among early and moderate to late preterm infants: Multiple Group Analysis...

Dear (address the participants) ....,

I am Shi Yangning, a doctoral student in the faculty of nursing, Burapha University, Thailand. Now I'd like to invite you to my research project. Before you agree to participate in the study, I will inform you of the details of the research project:

The purpose of this study is to examine the predictive factors of oral breastfeeding of multigroup preterm infants in Yancheng.

You are invited to participate in this research. Because you are a sample group of parents of preterm infants in the Newborn Intensive Care who meet the criteria for this study. It is the most important thing to give this information. This research will collect Data collected from May 2024 to – March 2025.

When you participate in the research, I would like you to truthful answer the questions about Breastfeeding self-efficacy, Breast milk sufficiency, Social support, Breastfeeding practice in NICU, and Breastfeeding support in the NICU. It will take about 30-40 minutes to answer the questionnaire in total. Also, I will assess the preterm infant by using the Premature Infant Index, Preterm Infant Oral Feeding, and Readiness Assessment Scale. In addition, at 3 and 6 months of child age, I will collect the follow-up data, which include Oral breastfeeding, Breastfeeding self-efficacy, Breast milk sufficiency, and Social support. You will get 10 Chinese yuan once to answer the questionnaire for compensation.

Since this research is a survey, the results may not directly benefit you. However, the research results can be used to create guidelines for improving the breastfeeding rate of premature infants

BUU-IRB Approved
26 Apr 2024

Version2.0/April 3, 2024

and provide a theoretical basis for the early implementation of breastfeeding for premature infants.

Your participation in this research is voluntary. You have the right to request withdrawal. You can leave this research project at any time without prior notice to the researcher. Which will not affect medical care for you. The information obtained from you will be kept confidential in the file cabinet. The questionnaire will not specify your last name and will be coded instead. Those who have access to the information are researchers and assistants. In addition, research reporting and research dissemination will be a descriptive overview and use information for research purposes only. Upon completion of the research publication, the researcher will destroy the research data within 1 year.

If you have any problems or questions inquiries can be made directly from the researcher on the day of data collection. Or you can inquire about this research anytime at Ms. Shi Yangning, telephone number +86 13814349382 or or e-mail is syn-021020@163.com. If the researcher fails to comply with the provisions of the statement, you can complain to the human research ethics committee of Burapha University in Thailand. The complainant can state the contents of the violation statement by phone (+66 038-102-620) or email (buuethics@buu. ac.th)

BUU-IRB Approved
26 Apr 2024

Participant's consent form

AF 06-03.1/v2.0

Consent Form

Research Code: ....G-HS009/2567........................

Research Title: .... Factors predicting oral breastfeeding among early and moderate to late preterm infants: Multiple Group Analysis..........

Date .... Month .... Year ....

Before signing the consent form for this research participation, I was provided the information about the purposes and the processes of the research in the participant information sheet, which the researcher has given to me. I have fully understood the preceding explanation and the researcher has undertaken to answer my questions willingly and without concealment to my satisfaction.

I voluntarily agree to participate in this research project. I understand I can withdraw from the research project at any time without giving a reason, and without it affecting any benefits that I am entitled to.

I have been given explicit guarantees that my information and identity will be kept confidential and will be shared only in the summary of research results. Disclosure of my information to the relevant authorities requires my permission.

The researcher Mrs. Shi Yangning has explained to me that all data and information of the participants will be kept confidential and only be used for this study. I have read and fully understood the above statements in all respects and have signed this consent document willingly.

In the case that I cannot read or write, the researcher has read the statement in the consent form to me until I fully understand it well. Therefore, I willingly signed or stamped my thumb on this consent form.

Participant's signature ....

(..)

Researcher's signature ....

BUU-IRB Approved ....)

26 Apr 2024

Version2.0/April 3, 2024

AF 06-03.1/v2.0

Note: If the participant gave thumbprint as their consent, witness signature will be needed.

BUU-IRB Approved
26 Apr 2024

Appendix C

Instruments English version

Appendix A. Patient General Questionnaire

Code: A-1 -

Part 1 Basic preterm infant information (To be filled out by medical staff)

1. Age: Week

2. Contact information:

-

Part 2 : Basic family situation

-
-

Part 3: Basic information of the fetus

-
-
-

Part 4: Basic information of postpartum women

-
-
-

19. Have you had experience with breastfeeding: □2Yes; □2 None

Appendix B: Preterm Infant readiness oral feeding behavior Assessment Scale

Code number			Postnatal age:	
Tube Feeding	( ) No			
	( ) Yes	( ) Nasogastric	( ) Orogastric	Volume: ml
Items \ Score		2	1	0
Corrected Gestational Age		≥34weeks	32～34 weeks	≤32 weeks
Behavioral Organization	Behavioral state	Alert	Drowsy	Sleep
	……	……	……	……
	……	……	……	……
Oral Posture	……	……	……	……
	……	……	……	……
				……
Oral Reflexes	……	……	……	……
	……	……	……	……
	……	……	……	……
	……	……	……	……
Nonnutritive Sucking	……	……	……	……
	……	……	……	……

	……	……	……	……
	……	……	……	……
	……	……	……	……
	……	……	……	……
	……	……	……	……
	Stress signs	Absent	1~3	>3
		Saliva accumulation ( ) Posture variation ( ) Apnea ( ) Nose wings trembling ( ) Tongue or jaw tremors ( ) Tonus variation ( ) Skin color changes ( ) Hiccupping ( )Crying ( )		
Total score				

- To be completed near the end of his or her shift, for each infant during the study period, in accordance with the study schedule.
- For each question, select one response that reflects the **WORST** experience observed for the infant during your shift.

Appendix C. The premature infant index (to be completed by the NICU nurse)

Factors	Levels	SHIFT 1 Start: ____ (e.g., 12:00) End: ____ (e.g., 24:00)	SHIFT 2 Start: ____ (e.g., 12:00) End: ____ (e.g., 24:00)	SHIFT 3 Start: ____ (e.g., 12:00) End: ____ (e.g., 24:00)	SHIFT 4 Start: ____ (e.g., 12:00) End: ____ (e.g., 24:00)
RESPIRATORY SUPPORT	Report the **GREATEST** level of support during your shift				
	Mechanical ventilation with endotracheal or tracheostomy tube or mask	□	□	□	□
	Respiratory pressure support [for example: high flow (≥2 L/min or ≥2000 cc/min) nasal cannula, nCPAP]	□	□	□	□
	Supplemental oxygen continuously not through a nasal cannula	□	□	□	□
	Continuous low flow (<2 L/min or <2000 cc/min) nasal cannula	□	□	□	□
	[If "Continuous low flow (<2 L/min or <2000 cc/min) nasal cannula" selected, complete the following, otherwise skip to Oxygen Administration] Please select source:	□ Air flow meter □ Oxygen flow meter	□ Air flow meter □ Oxygen flow meter	□ Air flow meter □ Oxygen flow meter	□ Air flow meter □ Oxygen flow meter
	Please select unit of measurement:	□ L/min □ cc/min	□ L/min □ cc/min	□ L/min □ cc/min	□ L/min □ cc/min
	[If L/min selected above] Please enter the greatest setting:	____ L/min	____ L/min	____ L/min	____ L/min
	[If cc/min selected above] Please enter the greatest setting:	____ cc/min	____ cc/min	____ cc/min	____ cc/min
	Supplemental oxygen but not continuously <u>OR</u> pulmonary medication administered (for example: diuretics, inhaled steroids, or inhaled bronchodilators)	□	□	□	□
	No supplemental oxygen <u>AND</u> no pulmonary medication administered (for example: diuretics, inhaled steroids, or inhaled bronchodilators)	□	□	□	□

OXYGEN ADMINISTRATION	Report the **HIGHEST** concentration during your shift *[Skip if "Continuous low flow (<2 L/min or <2000 cc/min) nasal cannula" selected for Respiratory Support]*				
	61% or greater	□	□	□	□
	51–60%	□	□	□	□
	41–50%	□	□	□	□
	31–40%	□	□	□	□
	22–30%	□	□	□	□
	21% (room air or no additional oxygen administered)	□	□	□	□
APNEA, BRADYCARDIA, DESATURATION	***For this shift, a bradycardia event is defined as ≤:***	____ beats/min	____ beats/min	____ beats/min	____ beats/min
	For this shift, a desaturation event is defined as ≤:	____%	____%	____%	____%
	Enter the total number of the following events, if any, that occurred during your shift: Apnea				
	• Event(s) that required intervention (for example: increasing oxygen, physical or mechanical stimulation, initiating compressions, bag mask ventilation)	____	____	____	____
	• Event(s) that did NOT require intervention	____	____	____	____

	Infant was in an open bassinet or cot and did NOT require additional support to stay warm	□	□	□	□
FEEDING	Did any feeds [including intravenous nutrition (solution containing amino acids or lipids) or enteral tube feeding] occur during your shift?	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No
	[If "Yes" selected above, complete below; if "No" selected above, skip to Weight]				
	Select one response that reflects the WORST experience for the infant during your shift				
	Any intravenous nutrition (solution containing amino acids or lipids) OR all feeds by enteral feeding tube (no breast or bottle)	□	□	□	□
	Some portion of feeds by enteral feeding tube AND some by breast or bottle but WITH a problem breathing or swallowing	□	□	□	□
	Some portion of feeds by enteral feeding tube AND some by breast or bottle but WITHOUT any problems breathing or swallowing	□	□	□	□
	All feeds by breast or bottle (no enteral feeding tube) but WITH a problem breathing or swallowing	□	□	□	□
	All feeds by breast or bottle (no enteral feeding tube) WITHOUT any problems breathing or swallowing but at least one feed took LONGER THAN 30 MINUTES	□	□	□	□

	Bradycardia • Event(s) that required intervention (for example: increasing oxygen, physical or mechanical stimulation, initiating compressions, bag mask ventilation) • Event(s) that did NOT require intervention Desaturation • Event(s) that required intervention (for example: increasing oxygen, physical or mechanical stimulation, initiating compressions, bag mask ventilation) • Event(s) that did NOT require intervention	____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
	Is the infant currently prescribed caffeine or other stimulant?	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No
THERMOREGULATION	Select one response that reflects the WORST experience for the infant during your shift				
	Infant was in a closed and heated incubator <u>OR</u> was under a radiant warmer	□	□	□	□
	Infant was in an open bassinet or cot and required additional support to stay warm (for example: multiple blankets, a heated mattress)	□	□	□	□

	All feeds by breast or bottle (no enteral feeding tube) <u>WITHOUT</u> any problems breathing or swallowing and all feeds took <u>30 MINUTES OR LESS</u>	□	□	□	□
WEIGHT	*[Complete ONLY for first administration for a given infant]* Enter last recorded weight <u>prior</u> to your shift. Please round to the nearest whole number: Date (DD-MMM-YYYY; for example: 01-JAN-2017): Time (00:00 to 23:59):	________ grams ____________ ____________			
	Was the infant weighed during your shift?	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No
	[If "Yes" selected above] Enter lowest recorded weight during your shift. Please round to the nearest whole number:	__ grams	__ grams	__ grams	__ grams

Appendix D

BSES-SF Items With Principal Components Factor Loadings

1 = Not at all confident 2 = Rarely confident 3 = Not sure 4 = Sometimes confident 5 = Always confident

Items	Not at all confident 1	Rarely confident 2	Not sure 3	Sometimes confident 4	Always confident 5
1.Determine that my baby is getting enough milk					
2. Successfully cope with breastfeeding like I have with other challenging tasks					
....					
....					
....					
....					
....					
....					
....					
....					
....					
....					
....					
14. Tell when my baby is finished breastfeeding					

Appendix E: Perceived Insufficient Milk Questionnaire

In item 1, please tick (√) your answer with "Yes" or "No". Item 2 to item 6, please read the following statements and write down the corresponding score that best fits them, from 0 to 10 indicating "strongly disagree" to "strongly agree".

Item	Strongly disagree						Strongly agree				
	0	1	2	3	4	5	6	7	8	9	10
1. Do you believe you are producing enough milk to satisfy your baby? Yes No											
2. My breast milk looks like it is nutritious enough to nourish my baby											
....											
....											
....											
6. My breasts seem to have enough milk											

Appendix F: Multidimensional Scale of Perceived Social Support Item and Subscale

In item 1, please tick (√) your answer with “Yes” or “No”. Item 2 to item 6, please read the following statements and write down the corresponding score that best fits them, from 0 to 10 indicating “strongly disagree” to “strongly agree”.

Item	Strongly disagree Strongly agree						
	1	2	3	4	5	6	7
1. There is a special person who is around when I am in need.							
2. There is a special person with whom I can share my joys and sorrows.							
....							
....							
....							
....							
....							
....							
....							
....							
....							
12. I can talk about my problems with my friends.							

Appendix G: BREASTFEEDING PRACTICE IN NICU QUESTIONNAIRE

The following entries are for surveys related to NICU behaviors related to breastfeeding practice for hospitalized preterm infants.

0 = Never\very rarely 1 = Rarely 2 = Sometimes 3 = Often 4 = Very often

	Items	Never\very rarely (0)	Rarely (1)	Sometimes (2)	Often (3)	Very often (4)
Breastfeeding advocacy	1. I received a breastfeeding health education pamphlet from the NICU personnel					
	2. The nurse told me about the benefits of breastfeeding for preterm babies.					
	....					
	....					
	....					
	....					
	....					
	....					
Knowledge about breastfeeding	....					
	....					
	....					

	....					
	....					
	....					
Collection and transport of breastmilk	....					
	....					
	....					
	....					
	....					
	....					
	....					
	....					
Screening and acceptance of breast milk of breast milk	....					
	....					
	....					
	....					

Appendix H: BREASTFEEDING SUPPORT IN NICU QUESTIONNAIRE

The following entry addresses a survey of breastfeeding support for hospitalized preterm infants in relation to NICU policy please fill "✓" inside the most relevant option as appropriate.

0 = Never\very rarely 1 = Rarely 2 = Sometimes 3 = Often 4 = Very often

Items	Never\very rarely (0)	Rarely (1)	Sometimes (2)	Often (3)	Very often (4)
1.I can be personally involved in the care of my infant.					
2.I can see my infant all the time.					
....					
....					
....					
....					
....					
8.I have access to nurses' instructions on infant feeding					

Appendix I: Preterm Infant Breastfeeding Behavior Scale (PIBBS)

Date:

Code number:

Observer (✓): A___ B___ C___ Mother (D)

Scale Items	**Maturational steps**	**Score**	
Rooting	Did not root	0	
	Showed some rooting behavior	1	
	Showed obvious rooting behavior	2	
Areolar grasp/placement	None, the mouth only touched the nipple	0	
(How much of the	Part of the nipple	1	
breast was inside	The whole nipple, not the areola	2	
(the baby's mouth)	The nipple and some of the areola	3	
Latched-on and	....	0	
fixed to the breast	....	1	
	....	2	
	....	3	
Sucking	....	0	
	....	1	

	....	2	
	....	3	
	....	4	
Longest sucking burst	....	0	
	....	1	
	....	2	
	....	3	
	....	4	
	....	5	
	....	6	
Swallowing	Swallowing not noticed	0	
	Occasional swallowing was noticed	1	
	Repeated swallowing was noticed	2	
Total score			

Appendix E

Instruments Chinese version

附录 A 患者一般调查问卷

代码：

第 1 部分 早产儿基本信息（由医护人员填写）

1.年龄：　　　周

2.联系方式：

•

•

•

第 2 部分：家庭基本情况

•

•

•

第 4 部分　产后妇女的基本信息

•

•

•

19. 您是否有过母乳喂养的经历：　□1 有；　□2 无

附录 B：早产儿口腔喂养准备程度评估量表

诊 断			体重：	
管饲与否	( ) 否			
	( ) 是	()鼻胃管	()口胃管	管饲奶量：_ml或天
分 值 项 目		2分	1分	0分
纠正胎龄		≥34周	32～34周	≤32周
行为	行为状态	清醒	半清醒	睡眠
	全身姿势	屈曲	部分屈曲	伸展
	肌张力	正常	部分正常	亢进
				减弱
口型	唇型	紧闭	半张	全张
	舌型	平		舌尖拾高
				凸起
				缩回
口腔反射	....	....	....	....
	....	....	....	....
	....	....	....	....
	....	....	....	....
非营养性吸吮	....	....	....	....
	....	....		....
	....	....	....	....
	....	....	....	....
	....	....	....	....
	....	....	....	....

	....	....	....	....
	评估过程的压力体征	无	1~3项	>3项
		唾液积聚()姿势改变()屏气() 鼻翼煽动() 舌头或下颌颤动()肌张力变化() 肤色改变 ()打嗝 ()哭闹 ()		
合计、备注				

根据研究计划表，在研究期间，每个婴儿的值班即将结束时填写。

对于每个问题，请选择一个反映在您当班期间观察到的婴儿最糟糕经历的答案。

附录 C. 早产儿指数（由新生儿重症监护室护士填写）

因素	级别	班次 开始时间： ______ （如，12：00） 结束时间： ______ （如，24：00）	班次 开始时间： ______ （如，12：00） 结束时间： ______ （如，24：00）	班次 开始时间： ______ （如，12：00） 结束时间： ______（如，24：00）	班次 开始时间： ______ （如，12：00） 结束时间： ______ （如，24：00）
	记录您在值班期间得到的**最大**支持程度				
呼吸支持	使用气管插管或气管造口术管或面罩进行机械通气面罩	☐	☐	☐	☐
	呼吸压力支持[例如：高流量（≥2 L/min或≥2000cc/min）鼻插管，nCPAP]	☐	☐	☐	☐
	不通过鼻插管持续给氧	☐	☐	☐	☐
	连续低流量（<2 L/min或<2000 cc/min）鼻插管给氧	☐	☐	☐	☐
	[如果选择"连续低流量（<2 L/min或<2000 cc/min）鼻插管"，完成以下步骤，否则跳至氧气管理] 请选择来源：	☐气流 米	☐气流 米	☐气流 米	☐气流 米
	请选择测量单位： [如果上面选择了L/min] 请输入设置最高值 [如果上面选择了cc/min] 请输入设置最高值	☐氧气气流 米 ☐ L/min ☐ cc/min ______L/min ______cc/min	☐氧气气流 米 ☐ L/min ☐ cc/min ______L/min ______cc/min	☐氧气气流 米 ☐ L/min ☐ cc/min ______L/min ______cc/min	☐氧气气流 米 ☐ L/min ☐ cc/min ______L/min ______cc/min
	补充氧气，但不是持续性的，或使用药物（例如：利尿剂、吸入类固醇、或吸入性支气管扩张剂）	☐	☐	☐	☐
	没有补充氧气，也没有使用药物（例如：利尿剂、吸入类固醇或吸入性支气管扩张剂）	☐	☐	☐	☐
氧气管理	报告该班次的**最高**浓度 [如果呼吸支持选择了"持续低流量（<2 升/分钟或<2000 毫升/分钟）鼻插管"，否则请跳过]				
	≥61%	☐	☐	☐	☐
	51 - 60%	☐	☐	☐	☐
	41 - 50%	☐	☐	☐	☐
	31 - 40%	☐	☐	☐	☐
	22 - 30%	☐	☐	☐	☐
	21%（室内空气或不额外供氧）	☐	☐	☐	☐
呼吸暂停，心动过缓，饱和降低	**对于这种转变，心动过缓事件的定义是≤**	______次/min	______次/min	______次/min	______次/min
	对于这种转变，饱和降低的定义为≤：	__________%	__________%	__________%	__________%
	请输入您当班期间发生的下列事件（如有）的总数在您值班期间发生的事件总数： 呼吸暂停 － 需要干预的事件（例如增加氧气、物理或机械刺激、开始按压、袋面罩通气）				
	-不需要干预的事件				
	心动过缓 － 需要干预的事件（例如增加氧气、物理或机械刺激、开始按压、袋面罩通气）				
	-不需要干预的事件				
	饱和降低 － 需要干预的事件（例如增加氧气、物理或机械刺激、开始按压、袋面罩通气）				
	-不需要干预的事件				
	婴儿目前是否服用咖啡因或其他兴奋剂?	☐是；☐否	☐是；☐否	☐是；☐否	☐是；☐否

	选择一个反映婴儿在您值班期间最糟糕经历的回答				
体温调节	婴儿在封闭的加热保温箱中，或在辐射加热器中	☐	☐	☐	☐
	婴儿在开放式摇篮或婴儿床中，需要额外的支持以保持温暖(例如：多条毯子、加热床垫)	☐	☐	☐	☐
	婴儿在开放式摇篮或婴儿床中，不需要额外的支持来保暖	☐	☐	☐	☐
喂食	是否进行过任何喂食[包括静脉营养(含有氨基酸或脂质)或肠管喂养]?	☐是；☐否	☐是；☐否	☐是；☐否	☐是；☐否
	[如果以上选择"是"，请填写以下内容，如果以上选"否"，请至体重				
	选择一个反映婴儿在您值班期间最糟糕经历的回答				
	任何静脉营养（含氨基酸或脂质的溶液)或所有肠内喂食管喂食(无母乳或奶瓶)	☐	☐	☐	☐
	部分食物由肠内喂养管喂养，部分由母乳或奶瓶喂养，但呼吸或吞咽有问题	☐	☐	☐	☐
	部分食物由肠道喂养管喂养，部分由母乳或奶瓶喂养，但没有任何呼吸或吞咽困难	☐	☐	☐	☐
	全部用母乳或奶瓶喂养（无肠道喂养管)，但有呼吸或吞咽困难	☐	☐	☐	☐
	用母乳或奶瓶（无肠道喂养管)喂养，无任何呼吸或吞咽困难但至少有一次喂养时间**超过 30 分钟**	☐	☐	☐	☐
	使用母乳或奶瓶（无肠道喂养管）喂养，无任何呼吸或吞咽困难，所有喂养用时**不超过 30 分钟**	☐	☐	☐	☐
体重	**[仅填写特定婴儿的首次用药]** 输入轮班前最后一次记录的体重，请四舍五入到最接近的整数： 日期(年/月/日，例如：2024年01日02日)： 时间（00:00 至23:59)	______克 ______________ ______________			
	婴儿在您值班期间是否称过体重?	☐有；☐没有	☐有；☐没有	☐有；☐没有	☐有；☐没有
	[如上文选择"是"]				
	输入您当班期间的最低体重记录，请四舍五入到最接近的整数：	__克	__克	__克	__克

附录D:母乳喂养自我效能量表短表 (BSES-SF)

此部分是描述您对自己母乳喂养的自信心程度，请勾选最能表达您想法的答

案，答案没有对错之分。

1=完全没有信心 2= 很少有信心 3 = 不确定 4 = 有时有信心 5 = 总是有信心

题号	题 目	没 完 有 全	信 有 心 一 点	不确定	信 比 心 较	信 非 心 常
1	我总能确保宝宝母乳充足					
2	我相信我能做好母乳喂养，就像以前我总能很好应付那些自己从来没有做过的事情一样					
3	…………………………………					
4	…………………………………					
5	…………………………………					
6	…………………………………					
7	…………………………………					
8	…………………………………					
9	…………………………………					
10	…………………………………					
11	…………………………………					
12	…………………………………					
13	…………………………………					
14	我总能够判断孩子是否吃饱了					

附录E：自觉母乳不足问卷

请您阅览下列陈述，勾选出（ √ ）最符合您自身情况的选项。在第 1 项中，请在您的 答案 中打上“是”或“否”。第 2 项到第 6 项，请阅读下面的陈述，并写出最适合它 们的相应分 数，从 1 到 5 表示“非常不赞同”到“非常赞同”。

条 目	非常不赞同 (1)	赞同 (2)	中立 (3)	赞同 (4)	非常赞同 (5)
您认为您有足够的母乳满足宝宝吗？ □2 是 □1 否					
2. 我的母乳看起来有足够的营养来滋养我的孩子					
3.					
4.					
5.					
6. 我的乳房似乎有足够的母乳					

附录 F：感知社会支持的多维量表

指导语：以下有12个句子，每一个句子后面各有7个答案。请您根据自己的实际情况在每句后面选择一个答案。例如，选择①表示您极不同意，即说明您的实际情况与这一句子极　不相符；选择⑦表示您极同意，即说明您的实际情况与这一句子极相符；选择④表示中间　状态。余类推。

1.在我遇到问题时有些人(领导、亲戚、同事)会出现在我的身旁
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同意；□7⑦极同意；

2.我能够与有些人(领导、亲戚、同事)共享快乐与优伤
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同意；□7⑦极同意；

3. ....
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同意；□7⑦极同意；

4. ....
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同意；□7⑦极同意；

5. ....
1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同意；□7⑦极同意；

6. ....
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同意；□7⑦极同意；

7. ....
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同

意；□7⑦极同意；

8. ………………………………………………
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同
意；□7⑦极同意；

9. ………………………………………………
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同
意；□7⑦极同意；

10. ………………………………………………
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同
意；□7⑦极同意；

11. ………………………………………………
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同
意；□7⑦极同意；

12. ………………………………………………
□1①极不同意；□2②很不同意，□3③稍不同意；□4④中立；□5⑤稍同意，□6⑥很同
意；□7⑦极同意；

附录 G：NICU 母乳喂养实践

以下条目是针对新生儿重症监护室与住院早产儿母乳喂养实践相关的行为调查，包括 4 个 部分： 1） 母乳喂养宣传；2）母乳喂养知识 3） 母乳的收集和运输；4） 母乳的筛选和接 受。

请您根据实际情况，在最贴切的选项上面画“✔”

	条目	从来没有 0	偶尔 1	有时 2	经常 3	总是 4
母乳喂养倡导	1.新生儿重症监护室的工作人员向我发放了母乳喂养健康教育小册子					
	2.护士告诉我关于母乳喂养对早产儿的好处					
	3.					
	4.					
	5.					
	6.					
	7.					
	8.					
母乳喂养知识	9.					
	10.					

	11.					
	12.					
	13.					
	14.					
采集及运送母乳的指导	15.					
	16.					
	17.					
	18.					
	19.					
	20.					
	21.					
	22.					
母乳的筛选及接受	23.					
	24.					
	25.					
	26. 护士会检查母乳的质量、母乳性状					

附录 H：NICU 母乳喂养支持问卷

以下条目涉及一项与新生儿重症监护病房政策有关的住院早产儿母乳喂养支持调查，请您根据实际情况，在最贴切的选项上面画“✔”

条目	从来没有 0	偶尔 1	有时 2	经常 3	总是 4
1.我能亲自参与照护婴儿					
2.我能经常见到婴儿					
3.…………………………………………					
4.…………………………………………					
5.…………………………………………					
6.…………………………………………					
7.…………………………………………					
8.我能得到护士对喂养婴儿的相关指导					

附录 I： 早产儿母乳喂养行为量表

日期

编号：

观察员 (✓): A___ B___ C___ 母亲 (D)

条目	**Maturational steps**	分数	得分
婴儿在寻找乳头进行吸吮时表现出的本能行为	未寻找	0	
	表现出一些寻找行为	1	
	显示明显的寻找行为	2	
婴儿在哺乳时的衔乳位置。（婴儿的口中有多少乳房部分）	无, 只有嘴巴触碰乳头	0	
	部分乳头	1	
	整个乳头，不包括乳晕	2	
	乳头和部分乳晕	3	
婴儿在哺乳时衔乳状态及时长	....	0	
	....	1	
	....	2	
	....	3	
婴儿在哺乳时的吸吮行为	....	0	
	....	1	

	....	2	
	....	3	
	....	4	
婴儿连续吸吮的最多次数	....	0	
	....	1	
	....	2	
	....	3	
	....	4	
	....	5	
	....	6	
婴儿在吸吮后是否进行了吞咽的动作	未注意到吞咽	0	
	偶尔注意到吞咽	1	
	重复注意到吞咽	2	
总分			

BIOGRAPHY

NAME	SHI YANGNING
DATE OF BIRTH	5 November 1982
PLACE OF BIRTH	Yancheng city, Jiangsu Province, China
PRESENT ADDRESS	School of nursing, Jiangsu Medical College , Jiangsu, China
POSITION HELD	2005-2019 Lecturer School of Nursing, Jiangsu Medical College, China
EDUCATION	2001-2005 Bachelor of Nursing Science, Nantong University, China.
	2012-2016 Master of Public Health Southeast University
AWARDS OR GRANTS	2001-2005 Scholarships in College of Nursing Nantong University, China.
	2012-2016 Scholarships in College of Public Health Southeast University