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Clinical Guidance in Breastfeeding

Physiology, Success, and Challenges

Edited by Birgül Livaoğlu Say

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Meet the editor

Dr. Birgül Livaoğlu Say is an Associate Professor and a specialist in Pediatrics and Neonatology. She completed her medical education at Ondokuz Mayıs University and later pursued her specialization in Pediatrics at Ankara Dışkapı Children's Health and Diseases Training and Research Hospital. She furthered her expertise with subspecialty training in Neonatology at Ankara Dr. Zekai Tahir Burak Women's Health Training and Research Hospital. Over the years, Dr. Say has worked in various prestigious institutions, including public and private hospitals, providing neonatal care. Currently, she holds a position at Alanya Alaaddin Keykubat University, where she contributes to the advancement of pediatric and neonatal healthcare. She has published numerous scientific articles in internationally recognized journals and has been involved in several neonatal research projects.

Contents

Preface

Breastfeeding represents one of the most fundamental aspects of human health and development, serving as the cornerstone of infant nutrition and maternal-child bonding.

The impetus for this book arose from the recognition that while breastfeeding is universally acknowledged as the optimal feeding method for infants, many mothers face significant obstacles that prevent them from achieving their breastfeeding goals.

Healthcare professionals, in turn, require evidence-based resources to support mothers effectively through these challenges. This text aims to bridge the gap between scientific understanding and practical application, providing readers with both theoretical knowledge and actionable strategies.

While emphasising the importance of maintaining the natural harmony between mother and baby, the study also presents the latest scientific evidence.

Drawing on decades of clinical observations, this thorough study reveals that, while almost everyone is physiologically capable of breastfeeding, achieving success requires the careful coordination of biological, psychological, social, and clinical factors.

As we confront evolving challenges in maternal and child health, the information contained in this book becomes ever more relevant. It is our sincere hope that this book will serve as an indispensable resource for all those committed to protecting, promoting, and supporting breastfeeding. By integrating scientific rigor with practical wisdom, we aim to empower healthcare providers and communities with the knowledge and tools necessary to help every mother achieve her breastfeeding goals, ultimately contributing to the health and well-being of families for generations to come.

We invite readers to engage with this text not merely as an academic volume, but as a practical guide that can make a tangible difference in the lives of mothers and infants.

We dedicate this book to all the amazing people who work tirelessly to make life better for mums and babies, and to all the mums who believe in the incredible experience of breastfeeding.

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Section 1

Anatomy, Endocrinology, and Dynamics of Milk Production

Chapter 1

The Physiology of Breastfeeding

Birgül Livaoğlu Say

Abstract

This scholarly work presents a comprehensive analysis of the physiological mechanisms governing lactation in the female breast, specifically focusing on the regulation of milk production and ejection from the alveolar-ductal network. Additionally, the text explores factors contributing to successful breastfeeding practices and examines the various challenges mothers may encounter during this process. Breast milk, in addition to its special nutritional value, has the ability to maintain both active and passive immunity. A substantial body of scientific evidence has unequivocally demonstrated the benefits of breast milk. Breastfeeding reduces the incidence or severity of a number of diseases, including bacterial meningitis; bacteremia, diarrheal diseases, infectious diseases of the respiratory system, including asthma, infectious diseases of the urinary tract; infectious diseases of the auditory system. Owing to the unique benefits of breast milk, the number of women worldwide who want to breastfeed and nurse their children has increased. The primary objective of this publication is to address barriers to breastfeeding by examining the physiological aspects of lactation, with the aim of increasing global breastfeeding rates to 50% and above. Concurrently, the text seeks to delineate professional medical support mechanisms to enhance the management of this process, considering both environmental and psychological factors.

Keywords: breast milk, breastfeeding, successful breastfeeding, breast milk content, mammary gland, lactogenesis

1. Introduction

Milk production, also termed lactogenesis, is a complex biological process that commences during pregnancy and intensifies significantly post-parturition. The process of milk production and secretion, known as lactogenesis, is regulated by an intricate interplay between hormones and physiological alterations. The entire process is meticulously regulated by hormones and physiological changes to ensure optimal infant nutrition and development [1].

Prolactin, secreted by the anterior pituitary gland, plays a pivotal role in stimulating lactogenesis, while oxytocin facilitates milk ejection through the let-down reflex. The composition of breast milk is dynamic, adapting to meet the evolving nutritional requirements of infants throughout the course of lactation. The complex process of lactation encompasses the development and functionality of specialized mammary glands. Hormonal fluctuations during gestation and the postpartum period initiate

the synthesis and secretion of milk. The composition of human breast milk is specifically tailored to fulfill the nutritional requirements of infants, providing essential nutrients, immunoglobulins, and growth factors that are critical for their optimal development [1].

1.1 Mammary gland development

Breast development begins in the embryonic stage, driven by mesenchymal-epithelial interactions mediated by autocrine and paracrine growth factors. By birth, the mammary glands exhibit significant structural and functional maturation, continuing their development postnatally with temporary functionality in infancy. Puberty marks the onset of accelerated breast development, regulated by the menstrual cycle and influenced by steroid hormones, prolactin, and oxytocin. Full maturation of the mammary glands occurs during pregnancy, primarily under the control of reproductive and metabolic hormones. The development of the human mammary gland is a complex process characterized by distinct stages from embryogenesis to lactation, involving intricate hormonal and molecular interactions. This organ undergoes significant changes throughout a female's life, particularly during puberty, pregnancy, and lactation, to fulfill its primary function of milk production [1–3].

1.2 Embryonic development

Mammary gland development begins in utero with the formation of a rudimentary structure that grows into a branched ductal tree embedded in the mammary fat pad at birth [2, 3]. Embryonic development of the breast involves a series of complex morphological and molecular processes that begin in the prenatal period and continue through various life stages. The development of the mammary gland is initiated during embryogenesis through mesenchymal-epithelial interactions, regulated by autocrine and paracrine growth factors such as epidermal growth factor (EGF) and transforming growth factor-α (TGF-α). Epithelial-mesenchymal interactions and signaling pathways, such as Wnt/ß-catenin and IGF-1, play critical roles in regulating growth and branching during embryogenesis [4, 5].

The first anatomical structure to appear is the "milk line," a thickened ectodermal ridge that forms around the fourth week of embryonic development. This milk line regresses except in the thoracic region, where it gives rise to the mammary gland. By the second month of gestation, the milk line invaginates into the underlying mesenchyme, forming the mammary bud, which later develops into the ductal-alveolar system of the breast. During the second trimester, the mammary bud branches into secondary buds, which elongate and begin to form the precursors of the ductal system. By the third trimester, the ducts undergo further branching, and epithelial cells begin to differentiate into luminal and myoepithelial cells. Secretory activity is observed in the epithelial cells, with the production of colostrum-like material in the alveolar structures. The development of the breast is influenced by various hormones, including estrogen, progesterone, and prolactin, which regulate ductal and alveolar morphogenesis. By birth, the mammary gland has achieved significant structural and functional development, with ducts and alveoli present, although further maturation occurs postnatally. This process is conserved across mammals, with some species-specific differences in timing and morphology [2, 6, 7].

1.3 Puberty and hormonal influence

After birth, female mammary glands remain underdeveloped until puberty, and rising estrogen levels, along with growth hormone and insulin-like growth factor, cause the mammary ducts to grow and the fatty tissue to enlarge, with estrogen effects being influenced by nearby connective tissue containing estrogen receptors [6].

During puberty, the onset of ovarian function triggers hormonal changes that lead to ductal elongation and branching, transforming the rudimentary ductal system into a more complex structure [2, 6]. Estrogen is pivotal for the proliferation of ductal structures within the mammary glands. It stimulates the growth and differentiation of breast epithelial cells, facilitating the development of the ductal system. Hormones such as estrogen and progesterone are pivotal in driving these morphogenetic changes [6]. This process, known as mammogenesis, is primarily driven by the hormones estrogen and progesterone. Progesterone promotes the maturation of alveolar structures in the breast and works synergistically with estrogen to enhance the overall growth and functional maturation of breast tissue. While prolactin is primarily associated with milk production, prolactin levels also increase during puberty, contributing to the development and differentiation of mammary tissues. These hormones stimulate the growth and differentiation of mammary tissues, including the development of milk-producing alveoli and an extensive network of ductal systems [8–10].

The onset of puberty marks the transition from prepubertal to pubertal growth patterns, and is characterized by the acceleration of breast tissue growth. The first observable change is the onset of breast budding, which indicates the beginning of breast development. The breasts undergo marked morphological changes during puberty. Ducts elongate and branch, while fat deposition in the breast increases, resulting in an overall enlargement of breast size [9, 10].

After puberty, breast development is influenced by hormonal changes throughout the menstrual cycle and during pregnancy. The mammary gland transitions into a functional state that is capable of lactation.

In summary, puberty is a critical period of breast development regulated by complex interactions between hormones, leading to structural and functional changes in the anatomy of the mammary gland. The mammary gland transitions to a functional state capable of lactation.

1.4 Pregnancy and lactation

During pregnancy, the mammary gland undergoes extensive remodeling with alveolar differentiation and tertiary branching, preparing the gland for milk production. Lactogenic differentiation involves molecular mediators, such as hormones, growth factors, and cytokines, which guide the transition from pregnancy to lactation [10].

Lactogenesis I refers to the initial stage of milk production in humans, occurring during the late stages of pregnancy. This phase is characterized by the differentiation of mammary epithelial cells and the onset of colostrum production, which is rich in proteins and antibodies. The development of the mammary gland and the onset of lactogenesis I are driven by hormonal changes during pregnancy, including increased levels of estrogen, progesterone, and prolactin [10]. The transition from lactogenesis I to lactogenesis II, marked by the onset of copious milk secretion, is influenced by various physiological and hormonal changes. Understanding the factors affecting

lactogenesis I and II is crucial for supporting breastfeeding mothers and ensuring optimal infant nutrition.

After parturition, the expulsion of the placenta results in a rapid withdrawal of progesterone, estrogen, and human placental lactogen during the 4–6 days after birth, while PRL concentrations remain high in the presence of insulin and cortisol, thus triggering lactogenesis II [11].

Following delivery, there was a sudden decrease in progesterone levels, accompanied by elevated prolactin levels. This hormonal shift triggers the onset of milk production, a process known as lactogenesis II, which typically occurs within 30–40 hours postpartum. During this phase, the mammary gland transitions from producing small amounts of colostrum to generating larger volumes of transitional milk. The initiation of lactation is also influenced by other hormones, such as cortisol and insulin, which play supportive roles in milk synthesis and secretion. Factors such as the timing of the first breastfeeding session postpartum, mode of delivery, and maternal metabolic conditions can influence the timing of lactogenesis. A delayed onset of lactogenesis II is often associated with poorer lactation outcomes [12]. Variables such as maternal age, education, and health conditions including gestational diabetes and hypothyroidism can affect the onset of lactogenesis II [13].

In addition to steroid hormones, prolactin, placental lactogen, and oxytocin (reproductive hormones), which are directly involved in the development of the mammary gland, there are several hormones classified as metabolic hormones that indirectly affect the development and functioning of the female breast. This group of hormones comprises growth hormone, glucocorticoids, thyroid hormone, and insulin. These hormones primarily coordinate the response of the female body to metabolic changes and stressors that occur during gestation, as well as postpartum during lactation. They can modulate the response of the mammary gland to reproductive hormones and indirectly regulate the synthesis and secretion of milk by altering the flow of milk precursors to glandular tissue [1, 13]. Furthermore, growth factors undoubtedly influence the development of the female breast during pregnancy.

1.5 Milk production

Milk is produced by epithelial cells lining the mammary alveoli, where it is stored until ejection. The milk is forced from the alveoli by the contraction of surrounding myoepithelial cells and exits through ductules into larger ducts, eventually reaching the nipple or teat for extraction [14, 15]. Human milk production, or lactogenesis, is a complex physiological process that involves several hormonal and structural factors within the mammary glands. The process of lactogenesis begins with the structural development of the mammary glands, which is influenced by various hormonal signals. The primary hormones regulating this process are prolactin and oxytocin. Prolactin is crucial for initiating and maintaining milk production, while oxytocin is essential for the milk ejection reflex, allowing milk to be released during breastfeeding (**Figure 1**) [2, 3].

At parturition, the initiation of milk secretion occurs, followed by the maintenance of milk production postpartum.

Infant suckling stimulates mechanoreceptors in the mother's nipple and areola that send the stimuli along the nerve pathways to the hypothalamus.

Infant suckling stimulates mechanoreceptors in the mother's nipple and areola, which send the stimuli along the nerve pathways to the hypothalamus. Stimulation of the posterior pituitary gland releases oxytocin that stimulates myoepithelial cells

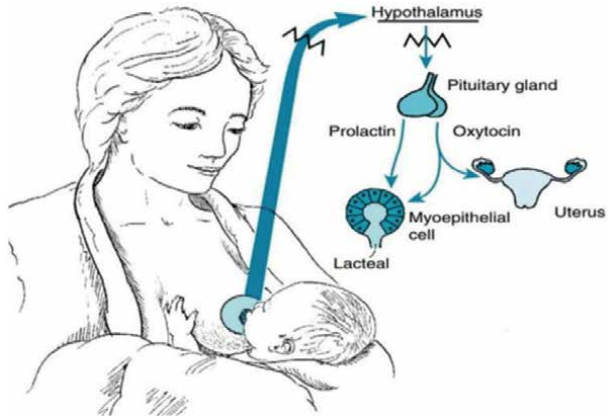

Figure 1.
Neuro endocrine reflex of lactation: Suckling triggers prolactin release for milk production and oxytocin-mediated milk ejection.

of the breast to contract and eject milk and [1, 2] stimulates the uterus to contract. Stimulation of the anterior pituitary gland releases prolactin, which is responsible for milk production in mammary alveoli.

The mammary glands consist of secretory acini that serve two main physiological goals: lactogenesis and milk ejection [4]. Cortisol also plays a role in regulating lactogenesis, contributing to the overall hormonal balance necessary for effective milk production [5]. The composition of human milk is notably characterized by a high concentration of lactose and relatively low levels of fat and protein compared to other species, which is tailored to meet the nutritional needs of the infant [4].

The central nervous system plays a crucial role in milk production and secretion during the established lactation phase in women. Complex interactions exist between the humoral and neurological mechanisms that regulate lactation and excretory reflexes.

It offers a detailed examination of the temporal and magnitude attributes of vacuum and compression stimuli that act on the sensory receptors of the breast areola during infant feeding. The release of oxytocin and prolactin from the neurohypophysis and adenohypophysis during the mother's milk excretion and secretion reflex is an impulse. The pulsatile characteristic of this release is thought to be mediated by distinct neuronal structures situated within the hypothalamus and its surrounding cerebral regions. During secretion, the components of milk can enter the alveolar cavity via transcellular and intercellular pathways [1, 14–16].

Manifests as minimal alterations in both the quantity and composition of milk secreted during the initial 1.5–2 days following delivery, a phase referred to as postpartum colostrum. Milk production during this interval typically remains consistent with the pre-birth levels. Hematological examinations of lactating women within this timeframe revealed that this inertia is primarily attributed to the persistence of elevated progesterone and estrogen concentrations, which remain high following pregnancy. This conclusion was substantiated by the analysis of prolactin, progesterone, and estrogen levels in the bloodstream [1, 13–16]. According to special studies conducted by Santoro Jr. et al. in 2010, the average amount of colostrum consumed by a newborn child in the first 24 hour was determined to be 15 ± 11 g. This amount did not show a relationship with the mother's subsequent

milk productivity or breastfeeding duration [17]. On the second day, the volume of colostrum excreted by the infant was not quantified with equivalent precision; however, the available data suggested that the quantity of colostrum was of comparable magnitude and approximated 30 ml [18].

During the early neonatal period, the immunological defense of the respiratory and gastrointestinal systems is of paramount importance. The ingestion of a small quantity of colostrum provides a highly concentrated dose of immune components, effectively serving as an initial "sanitization" of the entry surfaces to both the respiratory and digestive tracts.

The limited intake of colostrum in newborns raises concerns about meeting the energy demands during this period. However, it is important to note that colostrum has a significantly higher energy density (128–150 kcal/kg), approximately 2–2.4 times greater than that of mature milk (62.5–75 kcal/kg) [19, 20]. Additionally, energy requirements are initially compensated for by the mobilization of fat reserves in the newborn, which are notably higher than the fat reserves of neonates in other mammalian species [19, 21].

Colostrum is produced during the initial 4 days postpartum, followed by a 10–15 day period of transitional milk secretion prior to the abundant production of mature milk (after 15 days). The composition of milk undergoes significant alterations: sodium and chloride concentrations decrease, while those of lactose, immunoglobulin A (IgA), lactoferrin, and other components of mature milk increase. These changes are completed by 72 hour postpartum and precede the increase in milk volume by approximately 24 hour, corresponding to the terminal differentiation of alveolar mammary epithelial cells into lactocytes [11]. The changes result from altered gene expression of milk proteins (e.g., α-lactalbumin) and biosynthesis enzymes. Mammary epithelial cells (MECs) undergo restructuring, including organelle polarization, sealing of tight junctions (TJ) closure, and increased transport of substrates like amino acids, glucose, and ions, enabling a highly secretory state for milk production [11]. Milk production increases rapidly in the first 24 hours postpartum with frequent breastfeeding and newborn consumption, stabilizing around 750–800 ml/day after 1 month and remaining constant up to 6 months.

To optimize milk production, several factors must be considered. Nursing frequency is critical; infants are recommended to nurse at least 8 to 12 times in 24 hours to stimulate milk supply effectively [7]. Additionally, adequate hydration is vital for breastfeeding mothers, as fluid intake directly supports milk production [8]. Natural substances known as galactagogues can also enhance milk production, providing mothers with options to support lactation through dietary choices [6].

1.6 Breast Milk composition changes

Breast milk composition changes dynamically over the first 3 months of lactation. These changes are aligned with the infant's developmental needs, becoming more energy-dense with increased carbohydrate and lipid concentrations to meet the growing energy requirements of the infant [1]. The composition of breast milk changes over time, adapting to the nutritional needs of the infants. Colostrum, which is produced in the first few days postpartum, is rich in antibodies (particularly immunoglobulin A) and growth factors. It has a yellowish color and a thick consistency. Transitional milk follows, gradually changing to mature milk over the first 2 weeks. Human milk composition changes dynamically over the course of lactation to meet the evolving nutritional and immunological needs of the infant. During

breastfeeding, maternal milk provides both innate and adaptive immune components to the immunologically immature newborn. Unlike the non-specific innate defense, adaptive immunity is highly specific and retains memory of previously encountered pathogens. Secretory immunoglobulin A (sIgA) in milk reflects the mother's mucosal immune system's response to intestinal and respiratory pathogens, as noted by Brandtzaeg. Lactating mammary glands produce antibodies, mainly sIgA, which target pathogens in the mother's environment, offering infants protection against infections. Breastfeeding strengthens the immune connection between mother and child, reducing the risk of mucosal infections, which are a major cause of mortality in children under 5 years of age [22]. These immunoglobulins play a crucial role in shaping and supporting the maturation of the newborn's immune system, offering protection against pathogens. This is particularly significant as newborns lack their own immunoglobulin production early in life and rely on maternal IgG transferred *via* the placenta, which can be further supplemented through breastfeeding [23].

Colostrum, produced in the first few days postpartum, is rich in immunoglobulins and proteins, while mature milk, which develops after the first 2 weeks, contains higher levels of fat and lactose to support the infant's rapid growth and energy requirements [24]. Mature milk has a high-fat content and provides a balanced mix of nutrients for growing infants. The dynamic nature of breast milk composition extends beyond the initial transition period, with ongoing adjustments in the nutrient content occurring throughout breastfeeding. These changes are influenced by factors such as the time of day, stage of lactation, and infant's health status. Previous studies have reported decreasing concentrations of human milk oligosaccharides (HMO) and citrate and increased levels of lactose, glutamine, and alanine in mature milk. In addition, short-chain fatty acids (SCFA) are important energy sources for gastrointestinal tract maturation [4]. These changes are crucial for infant development, particularly in terms of energy provision and gastrointestinal maturation [25]. Lipids, which significantly contribute to the energy content of breast milk, are essential for neurodevelopment.

Mature milk is a complex emulsion of fat and aqueous fluid, serving as a complete nutritional source for newborns. It contains proteins (~3.5%), sugars (~7%), lipids (~4%), minerals (~0.5%), and water. The protein fraction includes α-lactalbumin and lactoferrin (LTF), iron-binding proteins with immunomodulatory and antibacterial properties, as well as caseins and immunoglobulins.

Carbohydrates, primarily lactose, glucose, galactose, and oligosaccharides, provide significant protection against pathogens. Milk contains carbohydrates, primarily lactose (a milk-specific disaccharide), glucose, galactose, and oligosaccharides, which provide significant protection against various pathogens. Fat, comprising ~4% of milk volume, contributes up to 50% of its energy content and consists mainly of triglycerides, fatty acids, cholesterol, phospholipids, and steroid hormones (glucocorticoids, progesterone, and estrogen). The fatty acid composition of milk fat is highly variable, influenced by maternal diet and feeding patterns [11].

The fat in human milk (milk fat globules, MFGs) constitutes approximately 4% of the milk volume and contributes to up to 50% of its energy content. MFGs primarily contain triglycerides along with various fatty acids, cholesterol, phospholipids, and steroid hormones (glucocorticoids, progesterone, and estrogen). Fat is the most variable component, as its fatty acid composition changes depending on the maternal diet and during breastfeeding. Additionally, bioactive lipids, such as prostaglandins (PGE2, PGD2, PGF2, and PGI2) and thromboxane A2, are also present in milk. These compounds are synthesized from arachidonic acid by cyclooxygenases, and may exhibit protective effects.

Extracellular vesicles (EVs) such as exosomes (40–100 nm in diameter) have been identified in milk. Exosomes are vesicles derived from multivesicular bodies (MVBs) that are formed through the endocytic pathway. During MVB biogenesis, cargo such as proteins, lipids, non-coding RNAs (including micro-RNAs and miRNAs), and mRNAs are sorted into internal vesicles (e.g., exosomes), which are released into milk following MVB exocytosis. In addition to their role in nutrition, exosomes may contribute to cell-to-cell communication and regulate developmental and immune processes, intestinal microflora, cellular metabolism, and gene expression after being ingested by the newborn [11, 26].

Breast milk is frequently considered an exceptional source of nutrition because of its unique and dynamic composition that is optimally tailored to meet infant requirements. It comprises an ideal balance of macronutrients, including proteins, lipids, and carbohydrates, as well as essential micronutrients, such as vitamins and minerals. Beyond its nutritional value, breast milk contains a wealth of bioactive compounds, including antibodies, enzymes, hormones, and growth factors, which play crucial roles in supporting the infant immune system, promoting healthy development, and providing protection against infections and diseases. Moreover, its composition adapts over time to align with the evolving needs of growing infants, rendering it an unparalleled source of nutrition. Numerous studies have elucidated the long-term benefits of breastfeeding, including enhanced cognitive development and a reduced risk of chronic diseases later in life. This remarkable complexity and adaptability underscore the irreplaceable role of breast milk in early childhood nutrition and health.

Conflict of interest

The authors declare no conflict of interest.

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Chapter 2

Understanding Insufficient Maternal Milk Production: Clinical Causes and Remedies

Vinutha U. Muktamath, N.H. Sunitha, Y. Ravi, Priya R. Hegde, Shweta Biradar, T.V. Saptagiri and Sunita Ilager

Abstract

Breastfeeding is universally recognized as the optimal form of infant nutrition, offering critical health benefits for both mother and child. Despite its importance, many mothers face challenges related to insufficient maternal milk production (IMMP), a multi-factorial issue influenced by physiological, psychological, and environmental factors. This chapter explores the clinical causes of IMMP, emphasizing the interplay of hormonal, anatomical, and behavioral factors that can disrupt lactation. Key contributors include endocrine disorders, breast conditions, maternal health issues, poor breastfeeding techniques, and socio-cultural barriers. The importance of early breastfeeding initiation, proper latch, and frequent feeding to sustain milk supply are also highlighted. Maternal nutrition, hydration, and the use of galactogogues are discussed as potential remedies to enhance lactation. Additionally, the chapter addresses the role of healthcare providers in offering evidence-based interventions, such as lactation support, nutritional guidance, and emotional counseling, to overcome breastfeeding challenges. By understanding the underlying causes of IMMP and implementing targeted strategies, healthcare professionals can empower mothers to achieve successful breastfeeding, ultimately improving maternal and infant health outcomes. The chapter underscores the need for continued research, awareness, and supportive policies to promote breastfeeding as a cornerstone of early childhood development and maternal well-being.

Keywords: insufficient breastfeeding, hormones, socio-cultural factors, galactogogues, counseling

1. Introduction

Breastfeeding is widely acknowledged as the optimal form of nutrition for infants, delivering vital nutrients and antibodies and fostering emotional connections between mother and child. Research has demonstrated the nutritional, immunological, and psychological advantages of breast milk for both mothers and infants, highlighting its significance as the best beginning for a child's life.

Key components of infant and young child feeding (IYCF) during the first 2 years include initiating breastfeeding early, exclusively breastfeeding for the first 6 months, providing appropriate and timely complementary foods from 6 to 24 months, continuing breastfeeding alongside complementary foods, ensuring sufficient dietary variety in supplementary feeding, and maintaining an adequate meal frequency [1, 2].

Human milk, with its nutritional, anti-infective, and biological properties, is essential for infant health and plays a key role in reducing mortality and morbidity, as childhood malnutrition remains a major public health issue. Evidence shows that early, exclusive, and extended breastfeeding for at least 23 months lowers neonatal and child mortality. Breastfeeding within the first hour can prevent 20% of neonatal deaths, while initiation within 24 h reduces the risk of all-cause and infection-related newborn mortality by 44–45%. Lack of exclusive breastfeeding increases the risk of diarrhea, illness, and mortality in infants (0–5 months) and children (6–23 months). Suboptimal breastfeeding is linked to higher rates of pneumonia and other adverse outcomes, contributing to over 800,000 child deaths annually. Additionally, breastfeeding protects against asthma, wheezing, and diarrhea, while exclusive and prolonged breastfeeding prevents ear, throat, and sinus infections. Nocturnal breast milk, rich in melatonin, promotes sleep, reduces gastrointestinal activity, and alleviates colic-related crying [3–5].

Breastfeeding also lowers the risk of rare conditions like necrotizing enterocolitis, botulism, urinary tract infections, sudden infant death syndrome, celiac disease, Crohn's disease, ulcerative colitis, insulin-dependent diabetes, and childhood cancer. Breastfed infants experience fewer diaper rashes due to lower bowel pH and are less prone to picky eating, as extended breastfeeding fosters acceptance of diverse tastes. Leptin in breast milk, known to regulate obesity in adults, helps control appetite and curb fat storage in newborns [5–7].

Breastfeeding is essential for cognitive, motor, and socio-emotional development while also reducing obesity risk. Its cognitive benefits come from key nutrients like breastfeeding is essential for cognitive, motor, and socio-emotional development while also reducing obesity risk. Its cognitive benefits come from key nutrients, like docosahexaenoic acid (DHA) and arachidonic acid (AA), galactose, immunoglobulins, and cholesterol, which support brain growth and neural development. The close maternal-infant interaction further enhances cognitive function by fostering secure attachment and emotional stability. Studies show that breastfed infants reach motor milestones earlier, as breastfeeding promotes physical growth and coordination. Additionally, appetite-regulating hormones like leptin help maintain a healthy weight, lowering obesity risk from infancy into adulthood [6–9].

Beyond physical benefits, breastfeeding strengthens socio-emotional development by promoting bonding through oxytocin, a hormone linked to affection, trust, and emotional regulation. Exclusive breastfeeding (EBF) is associated with faster recognition of positive facial expressions, improving social and emotional cue processing there by enhancing attachment and emotional intelligence. Maternal behavior influences early brain development and epigenetic programming, reinforcing breastfeeding's role in social bonding [10–12]. This emphasizes that breastfeeding is more than nutrition—it is a dynamic biological and social process that lays the foundation for cognitive, motor, and socio-emotional well-being with its complex interplay of nutrients, hormones, and social bonding.

Research has consistently shown that breastfeeding not only provides numerous benefits to infants but also has a profound impact on the health and well-being of

mothers. For example, breastfeeding helps the uterus to return to its pre-pregnant state more quickly, facilitating a smoother recovery after delivery. Additionally, breastfeeding can aid in weight loss after pregnancy, making it an effective and healthy way for new mothers to regain their pre-pregnancy figure. Furthermore, breastfeeding has been found to reduce the risk of mothers with gestational diabetes developing type 2 diabetes later in life. It also lowers the risk of ovarian cancer and pre-menopausal breast cancer, making it a crucial aspect of a woman's overall health and wellness. Moreover, breastfeeding has been shown to reduce the risk of osteoporosis, which can occur as a result of hormonal changes during menopause. While naturally extending the interval between pregnancies, breastfeeding also reduces the risk of complications associated with repeated pregnancies [13–15].

The benefits of breastfeeding extend beyond individual health, as it also has a positive impact on the environment and society as a whole. Breast milk is a natural, waste-free food that leaves no carbon footprint, making it a sustainable choice for families. Moreover, breastfeeding does not incur any costs, making it an accessible option for families of all income levels. By reducing the risk of illness, breastfeeding also leads to reduced hospital admissions and healthcare costs, resulting in significant savings for individuals and society as a whole [13, 14].

Over the past two decades, there has been a mixed picture globally when it comes to breastfeeding indicators. In low- and middle-income countries, the exclusive breastfeeding rate increased from 35% in 2005 to 42% in 2018 but still falls short of the global target of 50% by 2025 [16]. Despite its importance, many mothers struggle to establish and maintain adequate milk production, leading to frustration and early discontinuation of breastfeeding. Insufficient maternal milk production (IMMP) is a complex issue influenced by physiological, psychological, and environmental factors. To effectively support these mothers and their babies, healthcare providers must understand the clinical causes of IMMP and address modifiable factors, such as breastfeeding practices and maternal nutrition. By grasping the underlying causes and using evidence-based solutions, healthcare providers can comprehensively and empathetically address this issue [13–15].

This chapter examines the complex interaction of biological and external factors contributing to IMMP, emphasizing the importance of early assessment and targeted interventions to tackle these challenges, ultimately enhancing the health and well-being of both mothers and their children.

2. Anatomy and physiology of lactation

Normal lactation physiology begins well before birth, involving breast changes throughout puberty, pregnancy, and lactation. Breast development starts in a 20-day embryo as milk streaks, forming mammary ridges, ducts, and the nipple by week 6, with canalization by week 28. At birth, maternal hormones may cause temporary milk secretion ("witch's milk"), which is harmless.

Before puberty, mammary glands remain inactive until thelarche (ages 8–13.5), when hormones stimulate ductal and alveolar growth, marking the onset of development. Hormones such as estrogen, progesterone, corticosteroids, and thyroxine stimulate ductal and alveolar growth, influenced by menstrual cycles. Structural support comes from Cooper's ligaments and fatty tissue. Lactation involves both pituitary lobes and breast components like ducts, lobules, and stroma, with full maturation occurring only during pregnancy (**Figure 1**) [17–19].

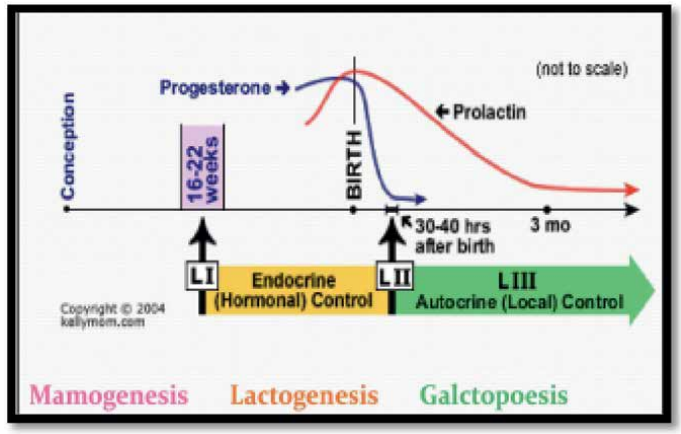

Figure 1.
Stages of lactogenesis.

3. Stages of lactogenesis and physiology of breastfeeding

Lactogenesis involves three distinct stages.

1. *Lactogenesis I (15–20 weeks of gestation)*: During this initial stage, hormone-driven synthesis of milk commences, and the production of colostrum begins around the middle of pregnancy.

2. *Lactogenesis II (30–40 h after childbirth)*: This stage is initiated by the act of giving birth and the expulsion of the placenta. It involves several hormones, including prolactin, insulin, cortisol, thyroxine, and oxytocin. It typically takes between 50 and 73 h for the breasts to reach full fullness. Factors such as obesity, diabetes, C-sections, or preterm birth can lead to delays in this process.

3. *Lactogenesis III (Galactopoiesis)*: In this final stage, milk production is regulated by autocrine mechanisms, which means that the continued production of milk relies on regular milk removal through breastfeeding. If nursing is infrequent or ineffective, it can lead to a decrease in milk supply [15, 19, 20].

4. Milk ejection reflex (MER)

The milk ejection reflex (MER), also known as the let-down reflex, plays a vital role in the production and flow of breast milk. This reflex is activated when the nipple and areola are stimulated, sending signals *via* the 4th intercostal nerve to the hypothalamus. In response, the hypothalamus releases oxytocin from the posterior pituitary gland, which prompts the myoepithelial cells surrounding the alveoli to contract and push milk into the ducts. Several factors can influence the MER. Enhancers include the sound of a baby crying, thoughts related to the infant, and preparations for breastfeeding. Conversely, stress, pain, embarrassment, and anxiety can inhibit the reflex [21]. In some cases, women may experience an overactive let-down, which can lead to excessive milk flow, causing discomfort for the baby, such as choking, gas,

or reluctance to nurse. The composition of breast milk varies throughout the feeding process. Colostrum, the first milk produced, is rich in immunoglobulin A (IgA), lactoferrin, and oligosaccharides. Mature milk, produced around days three to five postpartum, contains higher lactose levels. During a feeding session, the foremilk is starchy and released at the beginning, while the hindmilk, which is fat-rich, helps promote satiety and signifies the end of the feeding. To ensure that infants receive hindmilk, it is important for the breast to be fully emptied, as effective milk removal is essential for sustained breastfeeding, following a demand-driven cycle [17–20, 22].

5. Key hormones in lactation and mammogenesis

Lactation and mammogenesis are crucial processes in milk production, involving a complex interplay of hormones (**Figure 2**).

Key Hormones in Lactation:

- *Prolactin*: Stimulates the growth of the nipple and areola and drives milk production.
- *Human Placental Lactogen*: Supports mammary gland development during pregnancy. Estrogen: Promotes the development and branching of milk ducts while also causing the nipples to grow and darken.
- *Progesterone*: Encourages the growth of lobes, lobules, and alveoli, and inhibits lactation before birth.
- *Decline in Estrogen & Progesterone (post-placenta removal)*: Allows prolactin to function unimpeded.
- *Oxytocin*: Triggered by nipple stimulation, it initiates the milk ejection reflex (MER) and causes myoepithelial cells to contract, pushing milk through the ducts [23, 24].

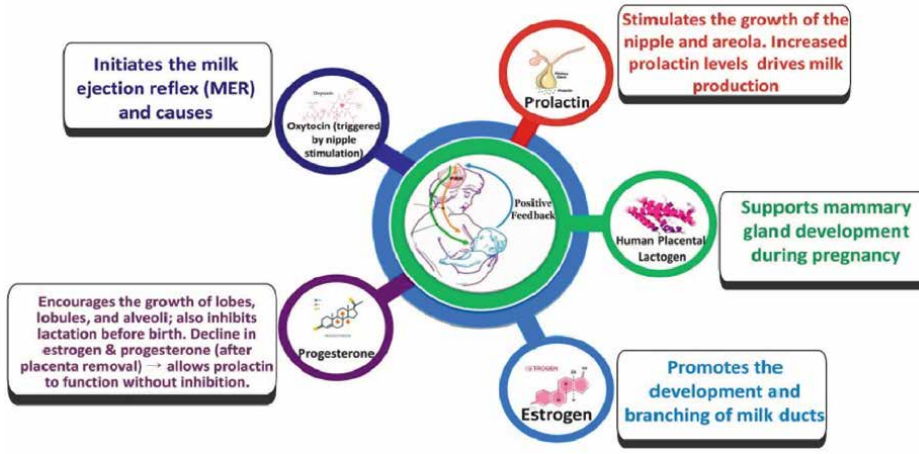

Figure 2.
Key hormones in lactation and their functions.

6. Mammogenesis

Mammogenesis refers to the growth and development of the mammary glands in preparation for milk production, starting with estrogen exposure at puberty and completing in the third trimester of pregnancy. Prior to pregnancy, breasts mainly consist of fatty tissue, lacking significant glandular development. During pregnancy, increasing levels of estrogen, progesterone, and prolactin lead to enhanced water, electrolyte, and fat content in the breasts, along with a doubling of blood flow and noticeable enlargement of subcutaneous mammary veins. Additionally, rising estrogen levels cause the nipples to grow and darken. The sebaceous glands of Montgomery around the areola enlarge and produce secretions that condition and lubricate the nipples during lactation. The final size of the mammary glands at term is influenced by various factors including pre-pregnancy size, fat distribution, the number of lobules formed, as well as age and parity. It is crucial to reassure patients, especially first-time mothers, that gland size does not correlate with functional capacity, helping to mitigate anxiety and feelings of inadequacy that may inhibit lactation [25, 26].

7. Clinical causes of insufficient milk production

Insufficient milk supply (IMS) remains a primary reason mothers discontinue breastfeeding early (6–8 weeks), yet it is not well understood. Research shows that

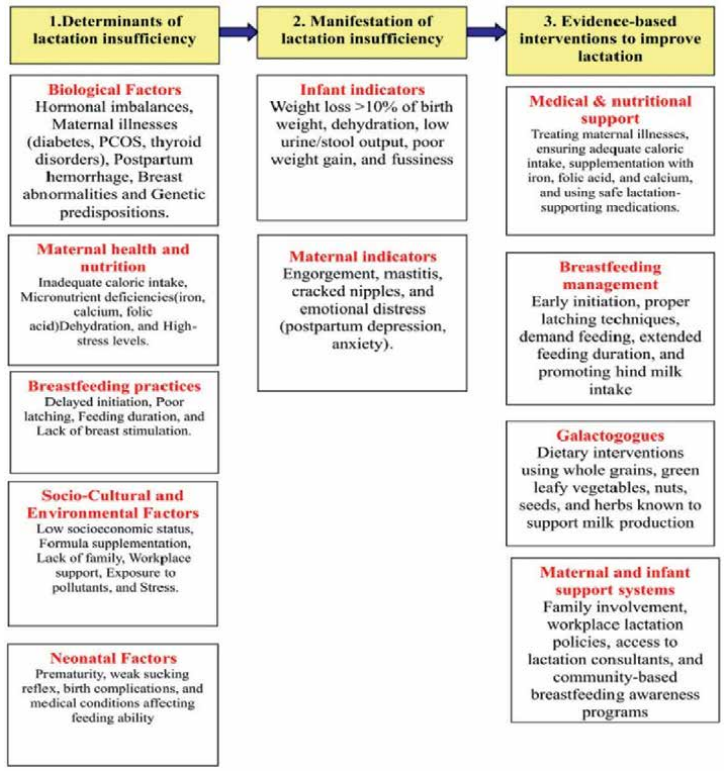

Figure 3.
Conceptual frame work for maternal lactation in sufficiency.

maternal reports of IMS stem from perceptions of inadequate breast milk for proper infant weight gain and satisfaction, which are the primary reasons mothers stop breastfeeding. Terms synonymous with lactation insufficiency include lactation inadequacy, breast milk insufficiency, lactation failure, mother's milk insufficiency (MMI), perceived insufficient milk (PIM), and insufficient breast milk. Lactation failure is defined as the necessity to introduce supplemental feedings within 3 months postpartum due to inadequate milk supply. Total lactation failure refers to a complete absence of milk flow or only a few drops following suckling for at least 7 days, while partial lactation failure indicates insufficient milk production or the need for supplemental feeding to ensure growth [23]. Various overlapping etiologies of IMS have been suggested, with biological, behavioral, and social factors influencing breastfeeding establishment and maintenance. Low milk supply may be primary (due to medical conditions or anatomical problems in the mother), secondary (from ineffective milk removal), or both (**Figure 3**).

8. Primary and secondary lactation insufficiency

8.1 Primary lactation insufficiency (intrinsic causes)

Primary lactation insufficiency due to intrinsic factors stems from developmental and endocrine conditions affecting glandular tissue growth and function. A key reason for the inability to produce adequate milk is breast hypoplasia. Furthermore, other causes of primary lactation failure can include severe illnesses like postpartum hemorrhage leading to Sheehan's syndrome, infections, or hypertension [23, 25].

8.2 Secondary lactation insufficiency (extrinsic causes)

Refers to a decreased milk supply caused by insufficient or ineffective milk removal from the breasts. Unlike primary lactation insufficiency, which results from medical or anatomical factors, secondary insufficiency is often due to factors such as inappropriate breastfeeding routines, poor latch, or supplementation with formula or prelacteal feeds leading to reduced milk production [25–27].

9. Further the etiology of lactation insufficiency can be classified as maternal, child and ecological (socio-cultural) factors

9.1 Maternal causes of lactation insufficiency

9.1.1 Endocrine conditions

The mammary gland is a dynamic organ, regulated by the coordinated actions of reproductive and metabolic hormones. These hormones support the gland's development from puberty and lead to the formation of a branched epithelial structure capable of milk secretion by the end of pregnancy. Estrogens and progesterone are crucial in promoting mammary growth, modulating prolactin's effects, and contributing to milk component synthesis. The onset of lactation occurs through the withdrawal of progesterone after the placenta is delivered, along with contributions from circulating prolactin and glucocorticoids. Once lactation begins, it is maintained

by increased production of prolactin and oxytocin from the pituitary gland, which is further stimulated by infant suckling. A delay in the initiation of lactation is a significant reason for early breastfeeding cessation. For successful lactation, both prolactin and oxytocin are necessary for milk production and release, relying on local mechanisms triggered by breast emptying; however, these mechanisms are still under investigation.

Lactation insufficiency, a common issue affecting many breastfeeding mothers, can be attributed to various factors including genetic and acquired endocrine disturbances. Maternal factors with potential endocrine effects on lactation include primiparity, obesity, preterm birth, Cesarean section, and retained placental fragments. Exposure to hormones from external sources, such as dietary and environmental pollutants, can also impact milk production by interacting with estrogen receptors and influencing hormone secretion and mammary gland responsiveness.

Current epidemiological studies largely focus on serum hormone levels, overlooking breast milk as a crucial excretion route, highlighting the need for further research. Deeper exploration into areas such as dose-dependent effects of exogenous hormones, obesity-related milk production issues, and optimal timing for hormonal contraceptives in breastfeeding women shed light on the complexities of lactation endocrinology and provide critical insights for improving lactation support [24, 25, 28].

9.1.2 Breast conditions

Inflammatory issues during lactation, such as engorged mastitis, abscesses, phlegmon, breast hypoplasia, retracted nipples, cracked nipples, and inverted nipples, can lead to insufficient milk production. Examining the nipples early in pregnancy is crucial for identifying truly inverted nipples as soon as possible, as this condition can hinder breastfeeding. Sub-nipple adhesions resulting from mild mastitis or trauma may cause the nipple to stay attached to the underlying breast tissue, preventing it from reversing when stimulated. A pseudo-inverted nipple becomes erect and protrudes upon stimulation, while a true inverted nipple retracts [29, 30].

Breast hypoplasia is a primary cause of insufficient milk production. Characteristics include a wide intermammary space, breast asymmetry, and a tubular breast shape. Women with hypoplasia may experience minimal breast growth during pregnancy and lack adequate glandular tissue for sufficient milk production. Approximately 5% of mothers may face primary lactation failure due to hypoplastic breasts or prior breast surgeries, such as mastectomy, reduction, or cyst removal. Surgical procedures, including nipple piercings, can disrupt ductal and neurological pathways, further affecting lactation [29, 30].

9.1.3 Maternal health conditions and medications

Various maternal illnesses and disorders can lead to breastfeeding complications. Since lactation involves complex biological processes, disruptions can result in insufficient milk supply or early cessation. In some cases, healthcare providers may recommend mothers discontinue breastfeeding to protect either their own health or prevent disease transmission to the infant. Severe anemia, malnutrition, and poor dietary choices can lead to early breastfeeding cessation due to micronutrient deficiencies. Conditions such as postpartum hemorrhage, depression, prenatal maternal stress, cancer, diabetes, HIV, PCOS, and thyroid dysfunction have all been linked to lactation insufficiency.

9.2 Postpartum depression (PPD)

Affects about one in ten women after childbirth, causing symptoms like anxiety, hopelessness, fatigue, social isolation, and suicidal thoughts. It can weaken the mother-infant bond and impair childcare abilities. While no direct link exists between PPD and milk production, studies suggest that low self-efficacy associated with PPD often leads to early breastfeeding cessation, sometimes within the first month. Anxiety, a common symptom of PPD, can be a significant factor in stopping breastfeeding [23, 30–32].

9.3 Obesity and related conditions

Obesity is frequently associated with diabetes and PCOS, both of which complicate breastfeeding. Diabetes, classified as type 1 (insulin-dependent), type 2 (insulin resistance or deficiency), and gestational diabetes (GDM), can impact breastfeeding duration. Since insulin plays a key role in milk production by supporting lipid and protein synthesis in breast milk, insulin deficiency can hinder lactation. Insulin is also involved in mammary cell differentiation, making its limitations detrimental to milk supply [23, 31, 33].

9.4 PCOS and lactation

PCOS, an endocrine disorder linked to obesity, is characterized by ovarian cysts, irregular menstrual cycles, infertility, and elevated androgen levels. Androgens, typically present in low amounts in females, inhibit lactation by interfering with the hormonal response to infant suckling. This disruption can significantly impact milk ejection [23, 30–32].

9.5 HIV and breastfeeding

Mothers with HIV risk transmitting the virus to their infants, leading to medical advice favoring early breastfeeding cessation to reduce transmission risks [23, 30].

9.6 Medications

Medications taken by pregnant or lactating mothers can significantly impact breast milk production and sufficiency. Certain drugs, such as hormonal contraceptives containing estrogen, decongestants, and dopamine agonists, can suppress prolactin levels and hinder milk production. Additionally, medications like diuretics and antihistamines may lead to dehydration, further decreasing milk production. Some psychiatric drugs, including selective serotonin reuptake inhibitors (SSRIs), can interfere with hormonal regulation, potentially affecting lactation. Furthermore, medications used to treat hypertension, such as beta-blockers, can decrease milk supply. Moreover, mothers undergoing treatment for thyroid disorders, like hypothyroidism, may experience changes in milk production due to the medication. It is essential for pregnant and lactating mothers to consult their healthcare providers before taking any medication, as some may be safer than others during breastfeeding, and alternative options may be available to minimize the risk of breast milk insufficiency [33–35].

9.6.1 Maternal nutrition

Nutrient needs during pregnancy and lactation are significantly higher compared to women who are not pregnant or nursing. Estimates suggest that energy requirements increase by about 300 kcal/day during the second and third trimesters and by 500 kcal/day during lactation. In practice, many women may need an additional 200 kcal/day, largely due to decreased physical activity and increased fat metabolism while breastfeeding. Additionally, the demand for many micronutrients, such as vitamins and essential minerals, becomes even greater during these stages. Poor maternal nutrition, particularly deficiencies in iron, calcium, and essential fatty acids, can negatively impact both milk volume and its nutritional quality. Although a mother's ability to produce enough milk typically remains resilient, it is affected by her body composition and nutritional status. The dietary calorie intake is crucial for maintaining adequate milk supply, and calcium requirements for milk production can be substantial, especially in areas with low calcium consumption. Inadequate calcium intake may lead to maternal bone loss, decreased calcium in breast milk, and potential issues with infant bone growth [16, 23, 36].

9.6.2 Wrong technique of breastfeeding

Evidence suggests that breast milk production typically aligns with infant demand. Rather than being directly influenced by blood prolactin levels, milk production is primarily regulated by breast fullness. The rate of milk synthesis is higher when the breast is thoroughly emptied compared to when it remains full. Researchers propose that a feedback inhibitor of lactation accumulates as the breast fills and is removed when milk is drained, controlling the synthesis rate. Since infants do not always fully empty the breast during feeds, milk production is not consistently at its maximum. However, mothers can enhance milk production by ensuring frequent and complete drainage [14, 16].

Many first-time mothers are unprepared for breastfeeding challenges and may become distressed by common difficulties. Most breastfeeding issues arise from suboptimal practices in the early postpartum period, such as delayed, infrequent, or ineffective breastfeeding, which can contribute to lactation insufficiency. A mother's confidence in breastfeeding can impact her experience with subsequent children. The *World Health Organization (WHO)* advises initiating breastfeeding within the first hour after birth, feeding colostrum, exclusively breastfeeding for the first 6 months, and continuing breastfeeding alongside appropriate complementary foods until at least 2 years of age for optimal growth and development [7, 14]. Breast milk composition is dynamic and changes throughout a feeding session [7, 16].

The distinction between *foremilk* and *hindmilk* is essential for understanding its nutritional impact. Foremilk, released at the start of a feed, is rich in carbohydrates and protein but lower in fat, helping quench the baby's thirst while providing necessary nutrients. Hindmilk, released later in the feeding session, has a higher fat content, making it creamier and more satiating for the baby. This transition in milk composition is thought to signal to the baby that the feeding session is concluding. Ensuring that breastfeeding sessions last *15–20 minutes per feed* allows for adequate breast emptying, which, in turn, stimulates further milk production. However, many women breastfeed for less than *10 minutes*, which may only drain the foremilk, potentially leading to inadequate fat intake for the infant and insufficient breast stimulation for sustained milk production. Hence the role of lactation consultant becomes very important in motivating mothers to cultivate successful breastfeeding practices [3, 7, 14, 37, 38].

9.7 Child factors

Factors in infants that contribute to lactation insufficiency often originate from ineffective breastfeeding techniques, which can be caused by several child-related factors. Infants with weak sucking reflexes, premature birth, or low birth weight might lack the physical strength and coordination to nurse efficiently, resulting in inadequate milk removal and, consequently, decreased milk production. Certain birth-related complications, such as birth asphyxia, can also hinder an infant's ability to nurse properly. Moreover, anatomical issues such as tongue-tie or cleft palate can impair an infant's ability to latch correctly, thereby reducing milk intake and signaling the mother's body to decrease milk production. Furthermore, certain neonatal health issues, including jaundice or infections, can cause an infant to become lethargic and nurse less often or ineffectively, further contributing to lactation insufficiency. Infants experiencing discomfort, such as gastroesophageal reflux disease (GERD), may exhibit short or infrequent feeding sessions, failing to provide the necessary stimulation for sustained milk production. By addressing these challenges through proper assessment and early intervention, breastfeeding outcomes can be significantly improved [14, 39].

9.8 Ecological (socio-cultural) factors

Ecological factors significantly influence lactation insufficiency by affecting both the quantity and quality of breast milk. Stress, pollution, inadequate nutrition, maternal smoking, alcohol consumption, and exposure to harmful chemicals can all hinder milk production. Key *socio-cultural* factors contributing to perceived lactation insufficiency include delayed breastfeeding initiation, lack of awareness about exclusive breastfeeding, formula supplementation, mother-infant separation, and painful postpartum conditions such as episiotomies and cesarean sections. Other contributing factors include low socioeconomic status (SES), early introduction of bottle feeding and pacifiers, insufficient workplace facilities for breastfeeding mothers, lack of professional guidance, aggressive marketing of infant formula, and inadequate support from family, spouses, or employers.

Moreover, environmental toxins like pesticides, heavy metals, and industrial pollutants can disrupt hormonal balance and may even contaminate breast milk, posing potential health risks to infants. *Climate-related* factors, such as extreme temperatures and dehydration, can further impact milk production. Addressing these ecological challenges and minimizing exposure to harmful substances is crucial for promoting optimal lactation and ensuring infant health [23, 30].

10. Assessment of lactation insufficiency

Several signs indicate that an infant may not be receiving enough milk during the first weeks of life. These include *weight loss exceeding 10% of birth weight, failure to regain birth weight within 2 weeks, and no urinary output for 24 hours*. Additionally, the absence of yellow stools in the first week and clinical signs of dehydration—such as jaundice, insufficient wet or soiled diapers, lethargy, excessive fussiness, unchanged stool color (not transitioning to bright yellow by day five), and lack of consistent weight gain by day four—are concerning indicators.

Another sign of inadequate milk intake is *the absence of swallowing during nursing sessions*. An infant may appear to suckle at the breast but may not actually be

swallowing milk. By the time a baby reaches *4 days old*, they should produce at least *six wet diapers and three bowel movements per day* to ensure they are receiving sufficient nourishment [40, 41].

11. Diagnostic tools and techniques

Evaluating low milk production in breastfeeding mothers requires an integrated approach utilizing clinical, biochemical, and observational diagnostic methods. Primary techniques include direct observation of breastfeeding, where a lactation consultant assesses the infant's latch, sucking effectiveness, and behavior during feeding sessions. Gathering maternal history and conducting assessments are essential to identify potential risk factors, such as hormonal imbalances, previous breast surgeries, or nutritional deficiencies. Monitoring infant weight gain patterns provides valuable information regarding the adequacy of milk supply. Additionally, test weighing— measuring the baby's weight before and after a feeding—can estimate the amount of milk transferred. Testing milk supply through hand expression and breast pump output can provide insights, although these methods may not always accurately represent actual milk production. More advanced diagnostic techniques, such as ultrasound imaging of the mammary glands and hormonal assays (including prolactin and oxytocin levels), can help identify underlying issues. Utilizing a combination of these methods ensures a thorough assessment of low milk production [14, 29].

12. Evidence-based remedies and interventions

12.1 Nutrition during pregnancy and lactation

Proper nutrition is essential during pregnancy and lactation, as it directly influences both maternal health and infant development. One of the key factors in lactation performance is the total volume of milk produced, which affects the infant's nutrient intake and the mother's nutritional requirements. Studies show that while maternal nutrient availability is essential for milk biosynthesis, but it alone does not guarantee increased milk production. The average milk production among women, regardless of dietary intake and nutritional status, is approximately 750–800 ml/day. Research indicates that increasing energy intake by about 25% during lactation helps meet energy demands, while a reduced intake can slightly decrease milk volume [25, 26].

12.1.1 Nutritional needs during pregnancy

A pregnant woman requires additional 340 kcal/day in the second trimester and 450 kcal/day in the third trimester, with a protein intake of 1.1 g/kg body weight or about 71 g/day to support fetal growth. A minimum of 175 g/day carbohydrates and 200–300 mg/day DHA are essential for fetal brain development [26, 42, 43].

Other critical nutrients include:

- Iron (27 mg/day): Prevents anemia and supports increased blood volume.
- Folic acid (600 mcg/day): Reduces the risk of neural tube defects.

- Vitamin D (600 IU/day): Essential for calcium absorption and bone health.
- Iodine (220 mcg/day): Supports fetal brain development.
- Zinc (11–12 mg/day): Important for immune function and growth.

Daily iron and folic acid supplementation is recommended to prevent maternal anemia and reduce the risk of low birth weight. Folic acid consumption throughout pregnancy is crucial in preventing congenital malformations like neural tube defects and cleft palate [26, 42–45].

12.1.2 Nutritional requirements during lactation

The nutritional needs of a lactating mother remain high to support milk production and maternal recovery. Additional energy intake of 500 kcal/day for the first 6 months postpartum and 400 kcal/day thereafter is necessary. Protein intake should be maintained at 71 g/day to ensure milk quality.

Other essential nutrients include:

- Calcium (1000 mg/day): Supports increased milk volume.
- Iron (9 mg/day): Prevents postpartum anemia.
- Folic acid (500 mcg/day): Supports maternal health.
- Vitamin D (600 IU/day): Essential for maternal and infant bone health.
- Iodine (290 mcg/day): Supports infant brain development.
- Zinc (12–13 mg/day): Strengthens immune function.
- Water (3–3.8 liters/day): Maintains hydration and milk production, preventing dehydration-related milk supply reduction [21, 37, 45, 46].

12.1.3 Nutritional recommendations for expecting and nursing mothers

- Prioritize nutritious foods like whole grains, sprouted legumes, and seasonal fruits and vegetables.
- Include sufficient sources of protein such as milk, meat, and eggs.
- Consume iron-rich foods, including meat, fish, poultry, and leafy greens.
- Boost iron absorption from plant sources by pairing them with Vitamin C-rich fruits like guava, gooseberries, and citrus.
- Regularly take iron, folate, and calcium supplements from 14 to 16 weeks of pregnancy through lactation.
- Avoid alcohol and tobacco.

- Limit caffeinated beverages like tea and coffee, as they bind dietary iron and hinder its absorption; avoid them before, during, or shortly after meals.

- Use medications only under medical supervision.

Adequate nutrition before, during, and after pregnancy is essential for maternal health and infant development, promoting optimal fetal growth, healthy birth weight, and effective lactation [21, 33, 46, 47].

12.2 Breast care and hygiene during pregnancy and lactation

Proper breast care during pregnancy and lactation is essential for maintaining maternal comfort and ensuring successful breastfeeding.

12.2.1 Breast care during pregnancy

- *Massage and Moisturization*: Applying oil to the nipples *3–4 times daily* during the last *2 months* of pregnancy may help maintain suppleness.

- *Hygiene*: Washing the breasts and nipples with warm water and keeping them dry can help maintain cleanliness.

- *Colostrum Formation*: By the *fourth to sixth month*, colostrum (a thick yellow fluid) may appear. While it can be expressed, doing so is optional. Keeping the area clean and dry is recommended.

- *Support*: Wearing a well-fitted *cotton brassiere* can provide the necessary support.

- *Nipple Preparation*: Gentle *nipple rolling exercises* in the last trimester may assist with breastfeeding readiness [7, 35, 47, 48].

12.2.2 Breast care during lactation

Proper care during lactation can help maintain comfort and reduce the risk of complications:

- *Daily Hygiene*: Washing the breasts with warm water and using a mild soap (if needed, no more than once daily) may help prevent dryness and cracking.

- *Air Drying*: Allowing the nipples to air dry after feeding can help maintain skin integrity.

- *Soothing Discomfort*: Warm compresses or ice packs may help relieve soreness.

- *Preventing Engorgement*: Ensuring the baby fully empties each breast during feeding may help regulate milk production. If the breasts feel overly full, excess milk can be expressed manually or with a pump.

- *Massage*: Gentle breast massage may help prevent clogged milk ducts.

- *Seeking Medical Attention*: Consulting a healthcare professional is advisable if there is persistent breast pain, swelling, burning sensations, cracked nipples, or rashes [47, 48].

13. Common breastfeeding challenges and solutions

13.1 Flat and inverted nipples

Nipples, being erectile tissue, can be encouraged outward through *manual stimulation* by gently rolling them between the thumb and forefinger or applying cold. Proper *positioning*, such as feeding in a *side-lying* position, may help babies latch more effectively. In persistent cases, the *double syringe technique* can be used to assist with nipple protrusion. Additionally, *nipple shields*, made of flexible silicone or rubber, can help babies who struggle to latch due to flat or inverted nipples.

13.2 Breast fullness and engorgement

Engorgement occurs due to excessive milk buildup, commonly caused by delayed breastfeeding initiation, bottle feeding, and early removal of the baby from the breast. The symptoms include swollen, painful breasts that feel tender and cause discomfort during movement. Frequent feeding helps empty milk and prevents engorgement. If the baby cannot empty the breast, express milk manually or with a pump.

13.3 Sore and cracked nipples

Poor attachment of the baby to the breast, where the baby sucks only from the nipple instead of latching onto the areola, is a common cause of discomfort during breastfeeding. If not corrected, this can lead to cracked nipples, mastitis, and even breast abscess. To prevent these issues, it is essential to ensure proper latching and positioning while breastfeeding. In cases where soreness persists, medicated creams may be used under a doctor's guidance to aid healing and provide relief.

13.4 Mastitis

Is a breast infection that can result from an unresolved clogged duct or spontaneous inflammation. Symptoms include redness, warmth, tenderness, lumps in the breast, fever, body aches, and severe fatigue. If left untreated, mastitis can progress to a painful pus-filled abscess, though abscesses can sometimes develop without prior mastitis. Seeking medical attention at the first sign of symptoms is crucial. In some cases, a doctor may advise temporarily stopping breastfeeding, and antibiotics may be prescribed to manage the infection (**Figure 4**).

Proper breast care before and after delivery is essential for preventing infections, ensuring comfort, and supporting successful breastfeeding. Addressing issues promptly with the right techniques and medical support can help mothers maintain their breastfeeding journey with ease [23, 47, 48].

Figure 4.
Common breastfeeding conditions affecting breasfeeding.

14. Galactogogues: Foods and herbs to enhance milk production

Galactogogues (or lactogogues) are substances believed to support the initiation, maintenance, or increase of breast milk production. The term originates from the Greek word "galacta," meaning milk. Across cultures, various foods and herbs have traditionally been used to enhance lactation. While research on natural galactogogues is limited, some evidence suggests they may boost milk supply by stimulating oxytocin, which aids milk ejection. These foods can be part of a balanced diet for lactating mothers, but they should be consumed in moderation [42, 43, 49].

Common Galactogogues:

1. *Whole Grains and Pulses*

   - Red rice, brown rice, broken wheat, millets, barley, and oats.
   - Legumes and pulses, known for their antibiotic and anti-inflammatory properties, may also support lactation.

2. *Vegetables*

   - *Beta-carotene-rich vegetables*: Beets, carrots, and yams, essential for milk production and providing iron and minerals.
   - *Dark leafy greens*: Kale, spinach, drumstick leaves (Moringa), broccoli, lettuce, coriander, Swiss chard, collard greens, and fenugreek, rich in calcium, iron, and phytoestrogens that may aid lactation.
   - *Others*: Mushrooms, asparagus, and pumpkins.

3. *Nuts & Seeds*

   - Almonds, cashews, walnuts, macadamia nuts.
   - Coconut, sesame seeds, sunflower seeds.

4. *Herbs & Spices*

   - Garlic, ginger, cumin, fenugreek, fennel seeds.

5. *Fruits*

   - Green papaya, pomegranate.

6. *Hydration*

   - Drinking plenty of water is crucial for maintaining milk supply.

7. *Brewer's Yeast*

   - A protein- and iron-rich nutritional yeast that contains phytoestrogens, which may support lactation [42, 49, 50].

15. Other herbal galactogogues

Shatavari, vervain, jivanti, ixbut, dill seed, coriander, cumin, cotton seed, fennel, chasteberry, caraway seed, borage, black seed, black cohosh, ashwagandha, aniseed, lemon balm, milk thistle, marshmallow root, nettle, red clover, red raspberry, alfalfa, and quinoa [42, 49, 50].

16. Infant support (breastfeeding initiation and practices for increased lactation)

16.1 Early initiation of breastfeeding

Newborns should be breastfed within 30 min of a normal delivery and within 4 h after a cesarean section. Early breastfeeding takes advantage of the baby's strong sucking and rooting reflexes, making latching easier. Sucking stimulates oxytocin release, which helps the uterus contract and reduces postpartum bleeding. It also supports successful lactation and strengthens the mother-baby bond [40, 41].

16.2 Feeding on demand

Breastfeeding should be done whenever the baby shows hunger cues, such as crying. Initially, frequent feeding helps establish milk supply, and over time, the baby will develop a natural feeding cycle, typically requiring feeds every 2–4 h. On average, newborns should be fed eight times a day for 15–20 minutes per session. Extended sucking ensures the baby receives hind milk, which is rich in fats and fat-soluble

vitamins essential for growth and satiety. Feeding only foremilk, which is high in lactose, may lead to digestive issues like diarrhea and perianal irritation. Babies should be breastfed from both breasts to ensure adequate milk intake and continued milk production [40, 41].

16.3 Ensuring proper latch

A correct latch is essential for effective breastfeeding. Signs of good attachment include the baby's chin touching the breast, a wide-open mouth, an outward-turned lower lip, and more areola visible above the baby's mouth than below. Poor attachment can lead to nipple pain, inefficient feeding, and air swallowing [40, 41].

16.4 Breastfeeding positions

The mother should hold the baby close, ensuring the baby's face is aligned with the breast and the body remains straight. Supporting the baby's whole body promotes better attachment. Various breastfeeding positions, such as lying down or the underarm hold, can provide comfort, especially for mothers recovering from a C-section [40, 48].

17. Conclusion

Breastfeeding is widely recognized as the most beneficial form of infant nutrition, offering essential nutrients, immune protection, and fostering a deep emotional bond between mother and child. Despite its numerous advantages, many mothers struggle with insufficient milk production due to a combination of biological, psychological, and environmental factors. Addressing these challenges requires a holistic approach that includes proper breastfeeding initiation, maternal nutrition, and effective lactation management.

Key factors such as *early initiation of breastfeeding, feeding on demand, and ensuring proper latch and positioning* are crucial in maintaining adequate milk supply. Poor breastfeeding techniques, including ineffective latching and short feeding sessions, can lead to inadequate milk intake, discomfort, and, ultimately, reduced milk production. Ensuring that infants receive both *foremilk and hindmilk* is necessary for their optimal growth and development.

Maternal health conditions, including *hormonal imbalances, postpartum depression, diabetes, PCOS, and thyroid disorders*, can further contribute to lactation insufficiency. Additionally, external factors such as *stress, poor dietary habits, exposure to environmental toxins, and limited family or workplace support* can negatively impact breastfeeding success. Providing mothers with proper education, guidance, and emotional support is essential in overcoming these challenges.

Preventive measures such as *breast care, proper hydration, and dietary supplementation with key nutrients like iron, folic acid, and calcium* can significantly improve lactation outcomes. The use of *galactogogues—foods and herbs traditionally believed to enhance milk production—can further support milk supply* when used in moderation. Moreover, addressing socio-cultural barriers, such as *aggressive marketing of infant formula, lack of breastfeeding-friendly workplaces, and misconceptions surrounding lactation*, is necessary to encourage sustained breastfeeding.

By implementing *evidence-based interventions* and promoting *breastfeeding-friendly policies*, healthcare professionals can empower mothers with the knowledge and

confidence needed to sustain breastfeeding. *Continuous research, awareness campaigns, and supportive healthcare systems* are essential in improving breastfeeding practices globally. Ultimately, fostering a breastfeeding-positive culture benefits not only *infant health and development* but also *maternal well-being*, contributing to a healthier future for both mother and child.

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Section 2

Successes and Challenges in Breastfeeding Practice

Chapter 3

Troubleshooting the Major Impediments to Successful Exclusive Breastfeeding

Richie Dalai, Rameshwar Prasad and Keshav Kumar Pathak

Abstract

Exclusive breastfeeding has multiple benefits both for the neonate and the mother. It is natural, low cost, and provides immunity to the neonate, apart from having nutritional benefits. It also prevents various morbidities in the lactating mother. Formula feeding, animal milk feeding, and other modes of feeding, on the other hand, have been associated with a higher prevalence of infections and necrotizing enterocolitis in neonates and should be avoided as much as possible. Both initiation and maintenance of exclusive breastfeeding till the first 6 months of life require adequate education and lactation support for the mother, starting from the antenatal period and continuing through the postnatal period. Family support is a major factor in ensuring the same beyond discharge. Apart from these, there are certain factors, which can be maternal, neonatal, demographic, social, and environmental, that can act as impediments to the successful establishment and maintenance of exclusive breastfeeding in the initial 6 months of neonatal life. Timely identification and tailored measures to rectify the modifiable issues related to breastfeeding are crucial to allowing the long-term establishment of successful exclusive breastfeeding.

Keywords: breastfeeding issues, flat nipple, breast engorgement, cracked nipple, exclusive breastfeeding

1. Introduction

Until the 1800s, breastfeeding was almost universal. After the introduction of formula feeds in the 1950s, exclusive breastfeeding rates have gradually decreased worldwide [1]. However, gradually, evidence pointed out the issues with formula feeding, and there was a renewed interest in breastfeeding. In preterm neonates specifically, the mother's milk is always preferable as it is associated with a lower incidence of sepsis and necrotizing enterocolitis and with better neurodevelopmental outcomes [2, 3]. Exclusive and adequate breastmilk feeding is an essential factor for not only proper growth and neurodevelopment of the neonate but also has various components that include lactoferrin, lysozyme, defensins, cytokines, haprtocorrin, immunoglobulins, leukocytes, and human milk oligosaccharides which act as important factors of innate immunity for the neonate and provide protection against

sepsis [4]. Both foremilk, which is rich in water and keeps the neonate hydrated, and hindmilk, which is rich in fats, are important for the neonate. The timely initiation of exclusive breastfeeding has also been associated with a significant decrease in neonatal mortality and, by extension, a decrease in under-five mortality globally [5]. Breastfeeding is equally beneficial for lactating mothers, as it reduces morbidities like obesity and type II diabetes mellitus in these individuals. It has also been shown to prevent breast cancer [6]. Both in developed and developing nations, breastfeeding has been found to reduce annual costs of health care for women and children [7, 8].

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) recommend breastfeeding within 1 hour of birth and exclusive breastfeeding for the initial 6 months of life [9]. These bodies have laid down 10 steps under the Baby Friendly Hospital Initiative (BFHI) to facilitate and ensure successful breastfeeding practices [10]. These include having a written feeding policy, helping the staff acquire knowledge and skills to support breastfeeding, counseling the pregnant individuals and their caretakers regarding the importance of breastfeeding, initiating immediate skin-to-skin contact post-birth and starting breastfeeding wherever possible (when resuscitation is not needed), help mothers maintain breastfeeding by managing common difficulties, avoiding any pre-lacteal feeds or fluids, ensure rooming-in and bedding-in wherever possible, help mothers to identify neonates' feeding cues, counseling for avoidance of bottle feeding and use of pacifiers, and last but not the least to ensure discharge readiness in the form of adequate ongoing support at home. It has been seen that ensuring these steps improves breastfeeding adherence [11].

Despite the numerous advantages of breastfeeding, adherence to exclusive breastfeeding is still poor worldwide both in terms of initiation of breastfeeding and adherence to exclusive breastfeeding, especially in low-middle-income countries (LMIC) [12]. The WHO targets at least 50% exclusive breastfeeding rates in the initial 6 months of life, by 2025 [13]. Multiple factors are associated with non-exclusive breastfeeding including poor antenatal care in the form of less frequent antenatal visits (<4), poor maternal knowledge regarding exclusive breastfeeding, first pregnancy, non-institutional delivery, cesarean section, delayed initiation of breastfeeding, pre-lacteal feeding, discarding of colostrum, incorrect positioning and latching techniques, maternal perception of inadequate breast milk output, maternal perception of breastmilk's limited value, mastitis, nipple problems (flat nipple and cracked nipple), and early return to work [14, 15]. Similarly, factors that are associated with a lower risk of non-exclusive breastfeeding include counseling regarding exclusive breastfeeding advantages, vaginal delivery, absence of breastfeeding difficulties, and adequate family and community support for breastfeeding [15]. Hence, it is essential to take all possible measures to curb the modifiable impediments to the successful establishment of breastfeeding and to timely achieve the WHO-set targets for exclusive breastfeeding.

2. The major impediments and solutions to modifiable factors

2.1 The socio-demographic factors

Poor socio-economic status, especially in LMICs, leads to less frequent antenatal visits and health-seeking behavior [16]. This results in fewer contacts for antenatal counseling, including those promoting education on exclusive breastfeeding practices

and the appropriate techniques. Women with 4 or more antenatal care visits have been shown to have higher odds of practicing exclusive breastfeeding than those with fewer visits [17].

Literacy levels also play a crucial role in breastfeeding practices among women [18]. Studies have shown that lower health literacy was associated with early cessation of exclusive breastfeeding [19].

Working mothers face difficulties in maintaining a balance between the care of the neonate and their employment. Various studies have found an association between long working hours and early return to work with lower exclusive breastfeeding duration [20].

2.2 Systemic medical factors

Maternal morbidities or pre-existing medical conditions like chronic kidney disease, rheumatic heart disease, neurological illnesses, severe anemia, and oncological diseases may impair the mother's ability to exclusively breastfeed her neonate. Such special circumstances require the initiation of breastfeeding as soon as the mother is clinically stable and in a supportive environment.

Post-surgical status, like in cesarean section births, it becomes challenging for the mother to breastfeed in the typical positions. Multiple studies have shown that as compared to vaginal delivery, those mothers who undergo cesarean section are less likely to practice exclusive breastfeeding [21, 22]. A supportive environment, adequate lactation counseling, and promoting feeding in a lying down position are essential in ensuring early initiation of direct breastfeeding in such situations.

2.3 Local medical or surgical factors

Additionally, medical conditions of the breast including inverted nipples, cracked or sore nipples, and breast engorgement if not identified and managed timely, also play a role in improper latching and form a vicious cycle that ultimately leads to poor exclusive breastfeeding rates.

2.3.1 Inverted nipple

Congenital nipple inversion has an estimated prevalence of 3–10% [23]. Acquired nipple inversion is much rarer and occurs due to oncological conditions of the breast, post-injury or post-surgery. Management of this condition depends on the grade of nipple inversion. Methods that have been used include the syringe method, Hoffman exercises, the rubber band method, and the breast pump method.

The syringe technique was first introduced by Kesaree et al. [24]. This method uses a pre-cut 20 ml syringe with a plunger inserted from the cut end. The smooth end of the syringe is then applied over the areola and the plunger is pulled till there is just acceptable pain. The plunger is held in this position for 10 seconds, and this entire method is repeated 10 times. Compared to the syringing method, the breast pump method to rectify nipple inversion has been associated with lesser pain and discomfort in mothers [25]. Hence, wherever possible and available, breast pumps can be used for the initial few days to allow nipple eversion and early latching. Hoffman's exercise involves gradual nipple stretching using the thumb and index fingers in horizontal and vertical planes. This is an alternative effective method [26]. The rubber band method uses a rubber band placed at the base of the nipple that helps maintain the nipple in an everted position after the syringe method has been used [27].

A systematic review comparing different methods found that all the methods were efficacious. They can be used alone or in combination with other methods, keeping in mind the feasibility of the intervention, the comfort level, and the choice of the lactating mother [28].

2.3.2 Sore nipple

Cracked or sore nipples are usually a result of improper positioning and attachment during breastfeeding which allow the neonate to suck predominantly on the nipple rather than the areola. The prevalence of cracked or sore nipples varies widely, ranging from 24–96% in different studies [29]. The condition is more common in the early days of breastfeeding, particularly during the first week postpartum. This leads to inadequate breastfeeding and resultant vigorous sucking on the nipple if left uncorrected. Over time, this leads to epidermal compromise and induces an inflammatory response in nipple skin leading to erythema, edema, fissure, and/or blisters of the nipple which may cause excessive pain and ultimately result in cessation of exclusive breastfeeding. Several risk factors may contribute to the development of cracked or sore nipples. These include the following

- Abnormal latch/suck dynamics
    - *Suboptimal positioning* – often cited as the most common cause of cracked nipples. Suboptimal positioning can lead to a shallow latch and abnormal compression of the nipple between the tongue and palate.
    - *Disorganized or dysfunctional latch/suck* – Premature Infants have low oral tone and reflux/aspiration or congenital anomalies that may be at risk for disorganized suckling [30].
    - *Ankyloglossia (tongue-tie)* – Poor tongue movement may lead to difficulty attaining a deep latch and is frequently associated with maternal nipple pain [31, 32].
    - *Biting or jaw clenching at the breast* – Neonates who bite while breastfeeding may cause nipple damage and breast pain. Conditions that may predispose to this situation include clavicle fractures, torticollis, head/neck trauma, mandibular asymmetry, and nasal congestion.
- Breast pump trauma

Injury may be either due to an exacerbation of pre-existing nipple damage secondary to suction pressure of the breast pump or due to overuse of the same [33]. Observing the mother while using the breast pump may clarify the cause(s) of trauma (i.e., improper flange fit, excessive high-pressure suction, or prolonged duration).

- Dermatoses

Breast dermatoses such as eczematous condition or less commonly, psoriasis may be secondarily infected with *Staphylococcus aureus*, causing impetiginous changes such as weeping, yellow crusting, and blisters [34].

- Candida infection: appears as a pink nipple/areola area with a shiny or flaky appearance of the nipple [35]. Factors predisposing a lactating woman to develop candida infections include the following:
    - *Thrush in the infant's mouth or the diaper (nappy) area (monilial rash).*
    - *Recent use of antibiotics in mother or child.*
    - *Use of pacifiers and bottles.*

Diagnosis of cracked or sore nipples is primarily clinical, based on the mother's symptoms and physical examination. The healthcare provider may assess the nipple for signs of trauma, such as cracks, fissures, or bleeding. Management of cracked or sore nipples involves a combination of self-care measures, breastfeeding technique adjustments, and medical interventions. The following strategies can help alleviate symptoms:

- *Proper latching technique*: Ensure the infant is latched correctly to avoid nipple trauma.
- *Frequent feeding*: Frequent feeding can help prevent engorgement and reduce nipple trauma.
- *Topical treatments*: Topical creams or ointments, such as lanolin or hydrogel dressings, can help soothe and protect sore nipples. Rubbing of hindmilk on the nipples and areola after each feed.
- *Antifungal or antibacterial treatments*: Medical treatment may be necessary to address underlying infections. Topical azoles antifungal cream (miconazole and clotrimazole) application on the nipple is the first line treatment for candida infection. Both mother and baby dyad should be treated. In resistance cases, systemic antifungal (oral fluconazole) is also indicated.
- *Avoid frequent washing of nipples with soap and water.*
- *Breastfeeding support:* Lactation consultants or breastfeeding support groups can provide guidance and reassurance.

2.3.3 Breast engorgement

Breast engorgement is a common but distressing problem many mothers face in the early postpartum period. This pathological condition arises due to the overfilling of the breast by milk, which leads to swelling, hardness, and pain in the breast and sometimes low-grade fever. The retention of milk in the alveoli creates pressure on the surrounding ducts. This pressure can impede the normal flow of milk through these ducts and further compress the nearby vascular and lymphatic systems [36]. This is often seen in situations where the breast is not adequately emptied, such as ineffective sucking, restrictive feeding practices, or delayed initiation of breastfeeding, and sometimes due to milk overproduction. Breast engorgement typically occurs between days 3–6 postpartum, during lactogenesis stage II, when the milk production

transitions from colostrum to mature milk, although this problem may occur later. In cesarean delivery, the onset of lactogenesis II and, thus, breast engorgement can be delayed by 24–48 hours, which is often due to factors such as hormonal changes, physical stress from surgery, and potential interruptions in skin-to-skin contact or early breastfeeding. This condition should be differentiated from the physiological fullness of the breast, breast edema, mastitis, and gigantomastia. The administration of large amounts of intravenous fluids during labor has been associated with postpartum breast edema, which can make latching and successful breastfeeding challenging [37]. Unrelieved engorgement may cause pain and discomfort, difficulty in latching, sore nipples, reduced milk output, and mastitis. There is no standardized tool to objectively assess the level of breast engorgement. However, a six-point rating scale ranging from 0 (no engorgement) to 6 (very firm and very tender) is one such method to subjectively gauge the severity of engorgement. In one study, approximately 72% of women reported a rating of 4–6 during the first 5 days after delivery [38]. Various methods aimed at resolving breast engorgement have been developed. Some of these are acupuncture, cabbage leaves, cold gel packs, protease complex, oxytocin, serrapeptase, acupressure, and different types of breast massage. However, a systematic review remained inconclusive about the effectiveness of these methods in relieving breast engorgement due to insufficient evidence [39]. Anticipatory guidance can help a mother feel more prepared to manage it when it occurs. The mothers should be advised to breastfeed on demand, proper latching, rooming-in, ice packs, pharmacotherapy for pain control, and manual or pump-expression of milk [40]. Together, these methods support milk flow, reduce the pain and discomfort of engorgement, and prevent further complications like mastitis.

In addition to the above interventions, proper positioning and attachment steps need to be followed in each case, to ensure breastfeeding adequacy. On-demand feeds 8–12 times a day should be allowed, with both day and nighttime feeds with each session at least 15 minutes duration. The breast should soften post-feed, and the neonate should sleep 2–3 hours between feeds.

The points for proper positioning include the following:

- The head and body of the neonate should be in a straight line.
- The whole body of the neonate should be well-supported.
- The nose of the neonate should be at the level of the mother's nipple.
- The neonate's abdomen should touch the mother's abdomen.

The points for proper attachment include the following:

- The neonate's mouth should be wide open.
- The nipple and most of the areola should be in the neonate's mouth.
- The neonate's lower lip should be everted.
- The neonate's chin should be in contact with the mother's breast.

An objective way to assess breastfeeding is through the LATCH score, which stands for latching, audible swallow, nipple type, comfort level, and hold, that can

be used by caregivers to assess breastfeeding sessions and intervene accordingly. An improvement in the LATCH scores would indicate that the interventions employed are effective [41]. The score is calculated out of 10, with each component having a maximum score of 2. It has been shown that exclusive breastfeeding at 6 weeks is associated with higher LATCH scores at birth and at 48 hours/discharge [42].

2.4 Neonatal factors

Certain special scenarios such as multiple births (twins and higher order births) and low birth weight neonates including small for gestational age (SGA) and intra-uterine growth restricted (IUGR) neonates, require special attention with regards to breastfeeding. In the case of twin births, maternal age and social support have been found to be associated with exclusive breastfeeding rates [43]. It has been shown that breastfeeding rates improve with counseling by nurses or caregivers [44]. However, a systematic review of the existing studies is inconclusive regarding the role of education and support in exclusive breastfeeding in case of multiple births [45]. In addition to the traditional cradle hold for feeding these neonates, a football hold or a

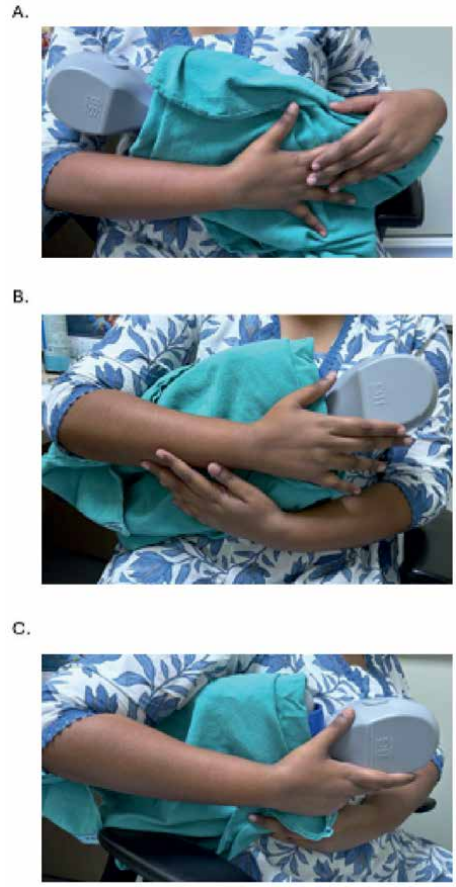

Figure 1.
Figure demonstrating various breastfeeding positions with the help of a neonatal manikin namely (A) Cradle position; (B) Cross-cradle position; (C) Football position.

combination of the cradle and football hold may be used for holding both neonates in case neonates are breastfeeding simultaneously [46]. In the case of IUGR neonates, it is essential to initiate timely breastfeeding to ensure euglycemia and catch-up growth postnatally. In these neonates in addition to the traditional cradle hold, a cross-cradle hold may be tried to ensure better positioning and attachment. The alternative breastfeeding positions have been included in **Figure 1**. However, some of these neonates, especially the preterm IUGR, may require additional measured spoon feeds apart from direct breastfeeding to ensure adequate weight gain.

3. Conclusions

Successful establishment of breastfeeding requires interventions from the antenatal period onwards. An adequate number of antenatal visits (at least 4) with ongoing counseling and support are crucial in the early initiation and maintenance of breastfeeding. Knowledge regarding proper positioning and attachment, signs of breastfeeding adequacy, and identification of feeding cues of the neonate are essential for solving most breastfeeding-related issues. For specific conditions of the breast as enumerated above, tailored timely interventions are additionally necessary. The most important factor, however, is to ensure a supportive environment for the lactating mother, throughout the hospital stay and beyond discharge.

Conflict of interest

The authors declare no conflict of interest.

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Chapter 4

The Success of Breastfeeding

Esin Okman

Abstract

Breastfeeding is universally recognized as the optimal method of infant feeding, as well as preventing various adverse conditions for the mother-baby dyad. Despite the established importance of breastfeeding, achieving breastfeeding success still remains a difficult challenge influenced by clinical, psychological, social, and systemic factors. This chapter explores the concept of breastfeeding success: (1) from initiation rates to exclusivity and duration; (2) maternal satisfaction, health, and infant conditions; (3) psychosocial influences such as family support and cultural attitudes; and (4) the critical role of health systems, policy frameworks, and community-based interventions in promoting breastfeeding continuity. Strategies to enhance breastfeeding outcomes and common barriers encountered by mothers are highlighted. A multidimensional, integrated approach is necessary to improve global breastfeeding success rates.

Keywords: breastfeeding, lactation success, infant nutrition, breastfeeding support, exclusive breastfeeding

1. Introduction

It is widely accepted that breast milk is the optimal nutritional source for infants, with breastfeeding being the most effective method of acquiring it. The World Health Organization recommends exclusive breastfeeding for the first 6 months of life and extending it to at least 2 years of age with complementary foods [1].

Breast milk is known to be the best for the infants, both in meeting nutritional demands and supporting the immune system. Furthermore, it is associated with significant reductions in infant morbidity and mortality, by the side of long-term health benefits for mothers [2]. However, global data indicate that only 48% of infants are breastfed exclusively until 6 months of age, with considerable regional variations [3]. This data emphasizes that sustaining continued breastfeeding is complicated and challenging.

The notion of "breastfeeding success" goes beyond just the initiation of lactation. It involves the optimal duration of breastfeeding, the sense of maternal confidence and satisfaction in breastfeeding, and overcoming common challenges and obstacles to breastfeeding. Clinical and psychological factors, such as maternal self-sufficiency and the support the mothers feel, are shown to improve the long-term breastfeeding outcomes [4–6]. In addition, healthcare practices, sociopolitical support structures, and the sociocultural perspective on breastfeeding must be taken into consideration to understand breastfeeding success [2, 7].

This chapter aims to describe the breastfeeding success. We will explore the definitions and measures of breastfeeding success and highlight the strategies that can be used to improve the breastfeeding outcomes.

2. Definitions and metrics of breastfeeding success

Breastfeeding success is an active and multifaceted concept that is beyond simply initiating breastfeeding. Assessing breastfeeding success is clearly necessary for healthcare providers, researchers, and policy developers to design strategies that effectively support and enhance breastfeeding practices [2, 8].

Early initiation of skin-to-skin contact and breastfeeding is known to be primary precursors of breastfeeding success. It is shown that the babies who were administered skin-to-skin contact within the first hour of birth are able to be exclusively breastfed [8, 9].

2.1 Definitions of breastfeeding types

According to the World Health Organization [10]:

Exclusive breastfeeding: Infant is fed only with the breast milk, ideally until 6 months of age (either directly from the breast or expressed).

Partial breastfeeding (mixed feeding): Infant is fed with non-human milk or/and infant formula besides breast milk.

Complementary feeding: Breastfeeding is combined with solid or semi-solid foods, ideally after around 6 months of age.

Predominant breastfeeding: Infant is fed with breast milk predominantly with liquids such as water or water-based drinks.

Each classification specifies a different degree of breastfeeding exposure and is related to short- and long-term health outcomes of the infants [2, 10].

2.2 Metrics for breastfeeding success

Quantitatively, success is often measured by exclusive breastfeeding rates and the duration of breastfeeding as recommended until at least 2 years of age [11]. On the other hand, assessing the breastfeeding success qualitatively includes the mother's knowledge, attitude, and willingness to breastfeed, infant's nutritional well-being, and comfort and satisfaction of both [12–14]. In some studies, the absence of significant breastfeeding problems, such as latch difficulties, nipple pain or trauma, insufficient milk issues, is defined as breastfeeding success [15]. If the mother feels confident and is contented with nursing her baby and the baby is thriving, in this case, it is a successful outcome regardless of the exclusivity timelines.

In some cases, an approach that takes into account parents' expectations can be a positive method of reducing mothers' stress. Concordance is a concept that has been introduced in recent years, which refers to how a mother wants to feed her baby and the extent to which she is able to fulfill this desire [16]. Even though it is promising for parents who may feel guilty when they are not able to provide stereotyped methods of breastfeeding, the concordance model has not yet been widely adopted in clinical guidelines or global health policy frameworks. Integrating concordance as a secondary or supportive outcome measure may allow for a more holistic understanding of breastfeeding success.

3. Global and national trends in breastfeeding initiation and continuation

In the past 5 years, global data shows a visible rise in breastfeeding practices, however, the rates are still under the international targets. Exclusive breastfeeding in the first 6 months postpartum has risen approximately 10% between 2010 and 2023, which reached out to 48% [3]. Global data shows that 71% of infants at the age of one are still receiving breastfeeding, yet this rate drops to 45% roughly at the age of two [3]. Nearly half of the world's children are not breastfed until the age of two, despite recommendations to do so.

Global public health initiatives have focused on improving breastfeeding. For exclusive breastfeeding under 6 months, the World Health Assembly's 2025 target is 50%, and the WHO/UNICEF Global Breastfeeding Collective targets 70% by 2030. Similarly,

Region	Country	EBF < 6 months	EIBF	Any BF at 1 year	Source
Global	Global	48%	46%	71%	WHO/UNICEF Report Card [3]
Asia	China	34.9%	55.8%	10.5%	Kang et al. [24]
Asia	China	90.9% (any BF)	—	72.2%	Tang et al. [25]
Asia	Nepal	23.2%	67.2%	—	Dharel et al. [26]
Asia	Bangladesh	74%	—	—	Islam et al. [27]
Asia	Turkey	36.9%	44%	—	Eskici and Karahan Yilmaz [28]
Asia	Turkey	71.4%	—	—	Meral Koc et al. [29]
Asia	United Arab Emirates	1.9%	80.6%	—	Radwan [30]
Asia	Malaysia	12% (after 3 months drop)	—	—	Amin et al. [37]
Africa	Ethiopia	48.1%	77.3%	—	Nemera [31]
Europe	Ireland	—	80.3%	66.7% (among initiators)	Leahy-Warren et al. [32]
Europe	Serbia	24%	—	—	UNICEF/Serbia [33]
South America	Brazil	45.8%	62.5%	52.1%	Boccolini et al. [38]
South America	Peru	—	49.7%	—	Hernández-Vásquez and Chacón-Torrico [34]
South America	Chile	—	95.2%	42.6%	Farkas and Girard [35]
Oceania	Australia	62% at 1–4 weeks	90%	—	Ogbo et al. [36]
North America	USA	27.2%	—	39.5%	CDC [22]

EBF <6 months = Exclusive breastfeeding under 6 months (only breast milk, no other liquids or solids). EIBF = Early initiation of breastfeeding (breastfeeding started within the first hour after birth). Any BF at 1 year = Any breastfeeding at 1 year of age.

Table 1.
Global breastfeeding indicators by country [3, 22, 24–38].

the target for early initiation is 70%, and for continued breastfeeding at 1 and 2 years is 80% and 60%, respectively by 2030 [3, 17]. In fact, out of 100 countries that updated their breastfeeding data since 2017, 70 have seen an increase in exclusive breastfeeding prevalence. This positive trend demonstrates that significant improvements are possible with appropriate support. In 2016–2022, 46% of newborns were breastfeeding within 1 hour of birth, which was much lower than the 70% targeted [3, 18].

When reviewing the literature of the last two decades, it is seen that rates and trends of breastfeeding practices vary from country to country. In the United Kingdom, Infant Feeding Survey reported that, from 2005 to 2010, breastfeeding initiation rose from 76% to 81%; however, exclusive breastfeeding at 6 months remains around 1%, which is some of the lowest in the world [19, 20]. According to CDC Breastfeeding Report Card 2022, in the United States, exclusive breastfeeding rate at the age of 6 months was 24.9% among the children who were born in 2019 [21]. This rate has risen to 27.2% among the children who were born in 2021 [22]. In Türkiye, a large-scale survey is conducted every 5 years by Hacettepe University Institute of Population Studies. According to 2018 data, exclusive breastfeeding rate was 40.7% under 6 months of age, and newborns breastfed within the first hour after birth was 71.3% [23]. In **Table 1**, global indicators from the studies and reports of the last decade are assessed.

4. Factors negatively affecting breastfeeding success

Breastfeeding outcomes are shaped by numerous factors undermining breastfeeding success. Socioeconomic, cultural, medical, and systemic barriers must be examined in detail.

4.1 Socioeconomic factors

In many countries, women with lower-income and less educated mothers have lower breastfeeding rates, due to a lack of support. Poverty can force mothers to turn back to work earlier [39]. Likewise, malnutrition of the mother developing from poverty results in low milk supply and is a barrier to sustained breastfeeding.

In low-income settings, lower health literacy hinders the understanding of breastfeeding recommendations. On the contrary, in some high-income countries, less flexible job conditions and the marketing of formula push breastfeeding into the background [39–41]. It is a conflict in both lower- and higher-income settings that economic pressure and work constraints, with mothers having short maternity leave and having to resume work soon after birth, make continuing breastfeeding a struggle.

4.2 Traditional and cultural factors

Traditional practices and beliefs heavily influence breastfeeding. Some communities show behaviors that should be avoided, such as giving newborns sugar water, herbal teas before the mother's milk comes in, viewing the colostrum as dirty or not enough for the baby, giving semi-solid or solid foods earlier than recommended under the belief that the baby is hungry [42]. Furthermore, sexualization of breasts, causing the mothers to feel uncomfortable about breastfeeding in public places, lessens the breast milk gradually by discouraging the mother from nursing on demand [43].

In some cases, family and the social environment of the nursing mother may act in a discouraging way, manifesting that the breast milk is not sufficient for the baby and pushing to use formula for the baby to thrive better [44]. Thus, a lack of social support from the environment of the mother negatively affects breastfeeding practices.

4.3 Medical and health factors

Maternal health issues such as severe illness, postpartum complications, postpartum depression, and breast surgeries are among the main reasons that prevent the breastfeeding [5, 45, 46]. From the infant's point of view, premature or severely ill infants admitted to the neonatal care unit have difficulty on breastfeeding due to being separated from the mother and being fed by tubes or bottles during the hospital stay [45, 47]. Other obstacles of breastfeeding originated from infants are tongue-tie and cleft palate, resulting in latch and sucking difficulties [48, 49]. Burden of these issues, both for the mother and the baby, can be eased with the appropriate support of healthcare workers.

Routine obstetric procedures such as a difficult labor or cesarean section may result in delayed breastfeeding initiation, because of fatigue of mothers, prolonged effects of medications, or drowsiness of the newborns [50]. Besides, common problems related to breasts like nipple pain, cracked nipples, mastitis, and abscess can be managed by the skilled support of the mothers [51, 52]. Interventions for these conditions should be done in a timely manner, before it is too late.

4.4 Systemic and policy factors

After the delivery, providing the mothers with support from the healthcare workers is a key point. If the maternity hospital is not equipped enough to raise the mother's knowledge and courage for breastfeeding, this undermines the efforts [39, 53, 54]. The absence of lactation services or routine follow-up clinics after the discharge leads the mothers to feel on their own and unsupported at home [53, 55, 56].

On the other hand, in countries where the International Code of Marketing of Breast-milk Substitutes is not implemented, such as the United States, mothers are exposed to advertisements and ideas of formula feeding, and free samples they can use [39, 57–59].

Short or unpaid maternity leave policies constitute a systemic barrier; the majority of women are not able to sustain exclusive breastfeeding when they turn back to work fulltime [39, 60]. Furthermore, the workplaces without a designated nursing space or nursing breaks exacerbate the situation [56, 61, 62].

When there are gaps in policies on breastfeeding regulations, aggressive and deceptive marketing practices by formula companies are exposed. A mother who has no choice but to turn back to work, who feels incompetent about nursing due to lack of knowledge, or who feels under social pressure in various ways is perfect prey for formula companies claiming the formula is the best substitute for breast milk.

5. Evidence-based strategies for improving breastfeeding success

Although there are myriads of barriers against breastfeeding, there is also a range of protective factors and facilitators that enhance breastfeeding success. Key positive influences include strong support systems, education and knowledge, enabling policies, and other resources that empower mothers.

5.1 Social support

The support from the family, friends, healthcare providers, and the community is one of the most affective positive factors. When a mother receives emotional encouragement and help from someone with household chores and taking care of other children, under these conditions, the mother would be fully concentrated on breastfeeding. In particular, help and support from the father of the baby is essential to ensure persistent breastfeeding [63]. Similarly, studies reveal that social relationships and encouragement from family and friends are important determinants of successful breastfeeding [64].

Likewise, social support groups can be established, like mother-to-mother breastfeeding support meetings or trained peer counselor's visits to new mothers. In this way, experiences can be shared, and the self-confidence of mothers who see that the same difficulties are experienced by others will increase.

5.2 Maternal education and knowledge

Adequate education and enhancing the knowledge of mothers is the key to breastfeeding success. Education of breastfeeding practices can start from antenatal period; attending pregnancy classes, reading, or receiving guidance from health professionals help mothers to be prepared what to expect. Knowing in advance how to feed the baby, what is a good latch, the importance of breastfeeding, and the outcomes that can be prevented by breast milk will make the mother more confident and comfortable with breastfeeding practices [65–67]. Educated mothers have higher self-efficacy scores and are more likely to exclusively breastfeed. One study found that a simple teach-back method education session for new mothers increased both their breastfeeding success and their self-efficacy compared to mothers who did not receive that targeted education [66, 68]. When the education goes beyond the mother to broader family, the support that mother feels will increase inevitably.

A mother's belief in her ability to breastfeed is a positive factor. High breastfeeding self-efficacy often comes from a combination of knowledge, prior experience, and early small successes.

5.3 Healthcare support

The information, patience, and devotion that doctors, nurses, midwives, and breastfeeding counselors will give to the mother in cooperation to overcome this difficult period are the steps that will carry breastfeeding success to the highest point. In the first hour after the delivery, a nurse helping the mother how to hold and position the baby to latch correctly will be a good start. Persistent consultancy will help the mother's capability to increase and continue breastfeeding. Evidence indicates that with the breastfeeding support from lactation consultants, early cessation rates decrease, and the duration and exclusivity of breastfeeding are enhanced [51].

Maternity care hospitals adapt themselves to "Baby-Friendly Hospital Initiative (BFHI)," significantly support breastfeeding practices, and have higher rates of breastfeeding initiation and exclusive breastfeeding [7, 69]. The WHO/UNICEF Ten Steps to Successful Breastfeeding (such as enabling immediate skin-to-skin contact after birth, rooming-in 24/7, and not giving formula or pacifiers unless medically needed) set mothers up for success (**Table 2**). Infants born in Baby-Friendly hospitals are more likely to be exclusively breastfed during the hospital stay and less likely to receive supplemental feeding [51, 69].

Step	Description
1	Comply fully with the International Code of Marketing of Breast-milk Substitutes and relevant World Health Assembly resolutions.
2	Ensure that staff have sufficient knowledge, competence, and skills to support breastfeeding.
3	Discuss the importance and management of breastfeeding with pregnant women and their families.
4	Facilitate immediate and uninterrupted skin-to-skin contact and support mothers to initiate breastfeeding as soon as possible after birth.
5	Support mothers to initiate and maintain breastfeeding and manage common difficulties.
6	Do not provide breastfed newborns any food or fluids other than breast milk, unless medically indicated.
7	Enable mothers and their infants to remain together and to practice rooming-in 24 hours a day.
8	Support mothers to recognize and respond to their infants' cues for feeding.
9	Counsel mothers on the use and risks of feeding bottles, teats, and pacifiers.
10	Coordinate discharge so that parents and their infants have timely access to ongoing support and care.

Table 2.
Ten steps to successful breastfeeding [70].

In addition, for better guidance to mothers, healthcare providers need training, too. In a Baby-Friendly hospital, medical staff should participate in a training program for lactation management to ensure they have the skills to assist breastfeeding effectively. Furthermore, they should understand and internalize the ten steps to successful breastfeeding.

6. Policy advocacy and societal changes

Alongside healthcare measures, workplace arrangements are critical for sustaining breastfeeding. Appealingly, maternity leave should be paid and long enough, to give time for the mother-baby dyad. Studies show that every paid month in excess is associated with longer breastfeeding duration [71]. Thus, extending the paid maternity leave is one of the most important steps that can be taken.

At workplaces, arrangements for mothers are vital, such as providing lactation breaks and private places for milk expression with the facility to store the milk they express during the day.

Regulations on the marketing of breast-milk substitutes are a policy-level strategy, and the WHO International Code of Marketing of Breast-milk Substitutes is the key tool to bring it to life. The Code bans formula advertisements and prohibits free samples or gifts from formula companies at maternity care hospitals, which moves away the misconception that formula can be used in place of breast milk without medical need. A strict control of formula marketing by governments is essential and valuable alongside other interventions.

The monitoring and follow-up of lactation to see how breastfeeding is going with check-ups or phone calls after discharge is useful. In this way, breastfeeding problems can be detected in the early period, and interventions can be arranged for individual occasions. By tracking the breastfeeding outcomes in particular terms like exclusive breastfeeding at 6 months or the duration of breastfeeding, the impact of policies can be evaluated and adjustments can be organized.

On a broader level, public awareness campaigns about breastfeeding can enhance cultural knowledge and attitudes. Mass media campaigns or social media tools can be used to explain the importance of breastfeeding and to clear up the misconceptions collectively. Governments and health officials should fund and prioritize actions to support breastfeeding, such as lactation consultancy services, breastfeeding education campaigns, and peer support programs.

7. Conclusion

Breastfeeding success is a complex and multifaceted outcome that goes beyond initiation or duration. It encompasses the maternal satisfaction, infant well-being, sociocultural attitudes, and systemic support. As conveyed in this chapter, myriads of factors can significantly affect breastfeeding outcomes negatively, nevertheless, with evidence-based supportive interventions, it is inevitable to overcome.

However, global breastfeeding rates remain below recommended targets because of persistent inequalities and obstacles. A strategy to close these gaps is necessary including culturally sensitive and comprehensive community programs, strict regulation of formula marketing, and the empowerment of mothers through accessible and continuous support systems. Breastfeeding must be accepted not only as a personal choice but also as a shared public health responsibility.

For healthier generations, breastfeeding success should be embraced, and everyone should work toward achieving it.

Conflict of interest

The author declares no conflict of interest.

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Chapter 5

Challenges in Breastfeeding

Halil Uğur Hatipoğlu

Abstract

This chapter analyzes the factors that lead to approximately half of mothers worldwide discontinuing exclusive breastfeeding before 6 months of age, despite the numerous well-documented benefits associated with this practice. The categorization of barriers is as follows: infant-related (latch refusal, prematurity, and orofacial anomalies); maternal-related (postpartum depression, hypo- or hyperlactation, and drug exposure); and macro-level factors (hospital routines, formula marketing, workplace restrictions). In accordance with prevailing data and guidelines, each chapter correlates the mechanism with practical solutions. The objective of this study is to furnish clinicians with a toolkit that is grounded in empirical evidence, with the aim of increasing the prevalence of exclusive breastfeeding and thereby enhancing outcomes for both mothers and their children.

Keywords: breastfeeding barriers, lactation difficulties, infant latch refusal, human milk, weaning

1. Introduction

Breastfeeding is an intrinsically tailored human nourishment that delivers macro- and micronutrients, hormones, immune cells, stem cells, live microbiota, and development-modulating exosomes [1]. Large meta-analyses have linked exclusive breastfeeding for ≥6 months to 64% lower diarrheal mortality, 28% lower otitis media incidence, and an average 3.4-point intelligence advantage [2–4]. Maternal benefits include reduced risk of type 2 diabetes (RR 0.79), breast cancer (RR 0.88 per 12-month increment), and postpartum depression [5–7]. Despite this, UNICEF reports that worldwide, only 47% of newborns start breastfeeding within the first hour, and global 6-month exclusivity sits at 48% [8]. A significant number of women encounter difficulties that have the potential to impede their capacity to breastfeed, consequently resulting in early weaning or inadequate breastfeeding. These challenges can be categorized as physiological, psychological, or social, and their successful overcoming requires appropriate support, education, and, in some cases, medical intervention. The present chapter explores the challenges commonly encountered in breastfeeding and provides clinical insights into the management of these difficulties to promote successful breastfeeding.

2. Infant-related challenges

2.1 Infant refusal to latch

The occurrence of an infant's unexpected refusal to breastfeed, often termed "breast refusal (BR)," constitutes a multifaceted and challenging facet of the breastfeeding experience. This situation is characterized by the infant displaying an unwillingness to suckle, turning away from the breast when offered, expressing distress through crying or screaming during attempts to breastfeed, or prematurely ending feeding. BR is characterized by the infant's refusal to consume breast milk, which typically manifests within the first postnatal week. The differential diagnoses for this condition include nipple confusion, pain from molding, oral thrush, and neuromotor discoordination. The overarching management strategy emphasizes the provision of uninterrupted skin-to-skin contact, auditory and olfactory cues, and the maintenance of a composed demeanor on the part of the caregiver. A 2024 Turkish cross-sectional study that surveyed 651 mother-infant dyads (0–24 months old) provided the most detailed epidemiological picture of (BR) to date. BR was reported by 35.6% of the mothers, most commonly after the third month of life, and was independently associated with lower household income, maternal comorbidity, inverted or flat nipples, non-bed-sharing sleep arrangements, lack of professional latch support at the first feed, and elevated Edinburgh Postnatal Depression Scale scores. Conversely, initiation of breastfeeding within the first hour, nurse-midwife assistance, bed sharing, and higher breastfeeding self-efficacy scores were protective. Although two-thirds of dyads ultimately recovered from BR, the odds of relatching fell sharply when artificial nipples were introduced, but increased threefold when refusal coincided with oversupply cues, such as breast engorgement or infant gassiness. The authors concluded that modifiable factors—early skilled support, optimized positioning, avoidance of bottles/pacifiers, and tailored counseling to bolster maternal self-efficacy—could substantially reduce both the incidence and duration of BR, thereby improving overall breastfeeding duration [9].

2.2 Prematurity and NICU admission

The mothers of preterm infants often face additional breastfeeding challenges. Preterm infants may have difficulty latching and sucking, which can reduce milk transfer. Furthermore, preterm birth is associated with delayed onset of lactogenesis, making it difficult for mothers to establish adequate milk production early on [10]. Preterm milk is richer in protein, sodium, and immunoglobulin A; nevertheless, volumes may lag unless mothers initiate expression within six hours of birth. Pumping ≥8 times per 24 h in the first week predicted volumes >500 mL by day 14 (OR 3.7) [11]. Cue-based feeding and kangaroo mother care halve the time to full oral feeds and reduce the length of hospital stay [12]. Fortification with human-milk-derived fortifiers preserves the gut microbiome diversity better than bovine-based products.

2.3 Orofacial anomalies: Ankyloglossia and cleft lip/palate

Ankyloglossia compromises the protrusion and peristaltic action of the tongue. When frenotomy is performed for clinically significant ankyloglossia, there is a clear and immediate improvement in reported maternal nipple pain and infant breastfeeding scores [13]. For cleft lip/palate, obturator plates, modified football hold, and

paced bottle supplementation of expressed milk enable partial breastfeeding until surgical repair at 3–6 months [14].

2.4 Hypotonia

The sucking behavior exhibited by infants with hypotonia, particularly those bearing trisomy 21, is characterized by diminished efficiency compared to their term counterparts. This observation pertains to a multitude of parameters, including pressure, frequency, and duration of sucking, in addition to smooth peristaltic tongue movement. A longitudinal study conducted over the initial year revealed a significant augmentation in sucking pressure by four months and subsequently by eight months. Concurrently, the sucking frequency increased by four months. Mothers generally report substantial improvements in feeding problems by 3–4 months of age. It is imperative that practitioners comprehend the temporal parameters in question, as this enables them to provide effective support to mothers and their hypotonic infants. This support can be instrumental in enhancing breastfeeding skills and attaining and sustaining a sufficient milk supply. This, in turn, can facilitate successful breastfeeding, despite the presence of significant difficulties at the outset. Breastfeeding a hypotonic infant can present certain challenges; however, many infants can successfully consume milk during this process. There is an absence of evidence to suggest that infants with trisomy 21 or other hypotonic conditions exhibit superior feeding outcomes compared to breastfeeding. Furthermore, there is no indication that these children require prior experience with bottle-feeding before attempting to breastfeed. In cases where such expertise is available, a team of professionals specializing in supporting infants with special needs to breastfeed should collaborate to assist the mother-infant dyad [15]. Side-lying positioning, external cheek support, and thickened expressed milk diminish the risk of aspiration.

2.5 Jaundice and breastfeeding

In breastfed infants, the extension of unconjugated hyperbilirubinemia into the third and later weeks of life in healthy newborns is a normal and regular extension of physiological jaundice. This condition is medically termed "breast milk jaundice." A factor present in human milk increases the enterohepatic circulation of bilirubin. Insufficient caloric intake owing to maternal and/or infant breastfeeding difficulties may also increase serum unconjugated bilirubin concentrations. The condition is referred to as breastfeeding jaundice or "breast-nonfeeding jaundice." This increase in the severity of physiological jaundice in newborns is attributable to the augmented enterohepatic circulation of bilirubin rather than to a factor present in human milk. In extreme cases, this may result in an infant being at risk of developing bilirubin encephalopathy. Optimal breastfeeding practices, which result in minimal initial weight loss and early onset of weight gain, have been associated with reduced breastfeeding jaundice and minimization of the intensity of breast milk jaundice. It is important to monitor bilirubin levels because high levels can cause lethargy and reduce the sucking reflex in babies [16].

2.6 Allergic proctocolitis

The most prevalent symptoms associated with food-induced allergic disorders in infants who are exclusively breastfed are cutaneous reactions (e.g., eczema) and

gastrointestinal symptoms. Severe food allergies are exceptionally rare. Hemorrhagic stool is the most prevalent gastrointestinal manifestation. This phenomenon typically manifests between 2 and 6 weeks of age, although some reports have indicated the onset of symptoms as early as the first day of life. The preponderance of cases can be attributed to dietary proteins excreted in the mother's milk, which induce an inflammatory response in the rectum and distal sigmoid colon, known as allergic proctocolitis. It is imperative to emphasize that infants who are breastfed and diagnosed with allergic proctocolitis are typically in good health, except for the presence of blood in their feces. Blood loss is usually minimal but can occasionally result in anemia and/or hypoalbuminemia. In exceptional circumstances, symptoms may result in a failure to thrive. Systemic manifestations, such as emesis, dramatic diarrhea, or abdominal distension, are rare and may suggest other allergic disorders of the gastrointestinal tract, including food protein–induced enterocolitis or enteropathy. Many cases resolve with the exclusion of maternal cow milk protein [17]. Milk transfer of bovine β-lactoglobulin falls below ELISA detection within 72 h of maternal avoidance [18].

3. Maternal-related and other challenges

3.1 Post-partum depression

Patients diagnosed with postpartum mental health issues who require medication should not be discouraged from breastfeeding because the benefits of breastfeeding outweigh the minimal risks associated with psychotropic medications. However, for women who choose not to breastfeed or experience an increase in mood or anxiety symptoms due to breastfeeding difficulties, formula-feeding may be a reasonable alternative. Therefore, effective treatment of postpartum depression is very important. If left untreated, postpartum depression can pose a risk to both mothers and children. These risks include impaired mother-infant interaction, decreased car seat use, decreased frequency of talking and reading with children, and more severe punishments. In addition, postpartum maternal depression has been associated with negative neurobehavioral development in children, including delayed cognitive development. It is difficult to separate the negative effects of infant exposure to psychotropic drugs from those of maternal psychopathology. However, the general consensus is that initiating or continuing effective psychotropic drug treatment provides important benefits such as preserving the mother-infant bond. During postpartum depression treatment, mothers and infants should not be left alone if possible, and support should be provided to the mother [19].

3.2 Radiologic imaging and nuclear medicine

Gadolinium is the most widely used contrast agent in MRI. It has been established that lactation can be continued without interruption after gadolinium administration. Gadolinium-based contrast agents are present in very low levels in human milk and are not well absorbed by the infant gut. No adverse effects were reported in lactating infants [20, 21]. For patients who receive I^{131}, I^{125}, N^{22}, and Ga^{67}, the Committee on Drugs of the American Academy of Pediatrics advises interruption of lactation for a minimum of three weeks. It is imperative that patients cease lactation a minimum of 4 weeks prior to undergoing whole-body scans with I^{131}, as the lactating breast exhibits a heightened I^{131} affinity compared to its non-lactating counterpart. This phenomenon can be attributed to the persistent radioactivity observed in the aftermath of the imaging procedures. To

mitigate the risk of radiation exposure to maternal breast tissue (and, by extension, the risk of cancer), it is imperative that patients refrain from lactation throughout the scan and the ensuing period. The judiciousness of imposing a period of restricted contact with the infant is contingent on the type of agent and the administered dose [22].

3.3 Hyperlactation (oversupply)

Several mothers have been observed to experience milk overproduction, a condition also referred to as hypergalactia or hyperlactation. Milk production is generally determined by the infant demand. However, in this particular instance, production exceeds the demand. Overproduction of milk by lactating mothers occurs early in lactation and may worsen in affected mothers with successive pregnancies. In particular, the rapid flow of milk during the mother's ejection reflex can prove excessively forceful, thereby impeding the infant's feeding ability. When fed, infants are susceptible to choking, coughing, and irritability. Infants may exhibit accelerated or inadequate weight gain. This phenomenon can be attributed to insufficient intake, a consequence of the infant's inability to process milk, or the absence of hind milk, which is characterized by its higher caloric content. It is generally accepted that milk overproduction is a transient phenomenon that typically resolves during the first few weeks of lactation. The management of milk overproduction and/or an overactive milk ejection reflex is based on clinical experience and consists of the following: It is recommended that mothers nurse their infants in a more upright position, with the mother leaning back or in the side-lying position. This allows infants to control the flow of milk better. The application of pressure to the areola using scissors, or to the breast using the heel of the hand, may result in reduced flow. Infants should be permitted to interrupt feeding as required, and frequent burping is often necessary. The efficacy of block feeding is well documented. In these cases, the mother used only one breast at a predetermined interval (typically 3 hours). It is hypothesized that the resultant milk stasis in the contralateral breast results in reduced lactation. For the subsequent three hours, the other breast was used. It is imperative to refrain from pumping to prevent sustained stimulation of milk overproduction. However, in certain cases, it may be necessary for some mothers to manually express their milk at the start of feeding. The application of cold compresses has been demonstrated as an effective method for alleviating discomfort. It is imperative that galactagogues, including herbal preparations such as fenugreek, be discontinued. The use of pharmacological interventions has not been well documented. The use of low-dose oral contraceptives or pseudoephedrine has been shown to be effective in such cases. Both these agents are considered safe for lactating mothers. However, it is important to note that they should be used with caution because of their diminishing effect on milk production and should be avoided for the first 2 weeks until milk production is well established. Pseudoephedrine induces irritability in infants [23–25].

3.4 Impaired lactation

Impaired lactation can be attributed to delayed lactogenesis or insufficient lactation. Delayed lactogenesis is diagnosed when the initiation of copious milk production is delayed beyond 72 hours after birth. It has been demonstrated that the majority of women who experience delayed lactogenesis are capable of achieving full lactation and exclusive breastfeeding. Insufficient lactation is diagnosed when a woman is unable to achieve an adequate breast milk supply to exclusively breastfeed her infant. It is identified when there is an absence of postpartum breast engorgement and milk

production despite sufficient stimulation and adequate drainage of the breast. It has been established that some women may experience insufficient lactation, resulting in minimal breast milk production. In other cases, although the production is higher, it is inadequate to meet the nutritional needs of the infant. Diabetes mellitus, maternal obesity, polycystic ovary syndrome, thyroid dysfunction, Sheehan's syndrome, and retained placental fragments are considered to be pre-glandular causes of impaired lactation. In contrast, breast surgery and insufficient glandular tissue are recognized as glandular causes. Postglandular-related factors comprise a number of infant-related elements (including cleft lip/palate, ineffective sucking, ankyloglossia, and lip ties), maternal medications, preterm birth, and smoking [26]. Domperidone increases milk output but carries a QT-prolongation risk [27].

3.5 Dysphoric milk ejection reflex

Dysphoric Milk Ejection Reflex (D-MER) presents as a brief wave of anxiety, sadness, hopelessness, or irritability that occurs with a let-down and lasts a few minutes. It is a commonly held view that stress, fatigue and dehydration have a detrimental effect on the sensation. It is important to note that the condition often improves with age. It has been hypothesized that the occurrence of distractions, such as the ingestion of food or viewing television programs, during breastfeeding may be beneficial. In many cases, the mere identification of the condition, coupled with the explanation that it constitutes a physiological response to a letdown, proves therapeutic. In certain cases, the condition manifests again during subsequent pregnancies [28].

3.6 Return to work

The re-employment of working mothers carries a potential risk of interruption to their breastfeeding practices, which is associated with an increased likelihood of breastfeeding exclusivity [29]. Corporate lactation programs that supply private rooms, hospital-grade pumps, and flexible breaks improve breastfeeding duration [30]. Therefore, policies should be developed to increase the scope of these programs and provide greater support for exclusive breastfeeding.

3.7 Planned and abrupt weaning

The timing of weaning was a personal decision made by the mother in the context of her social setting. This decision is influenced by factors such as subsequent pregnancies, career choices, and maternal health. The AAP recommends that breastfeeding be continued for at least one year and supported for two years and beyond, as mutually desired by the mother and child [31]. If rapid weaning is necessary, such as due to maternal illness it is recommended; to wear a tight-fitting bra night and day, to change breast pads often to keep nipples dryif milk is leaking, to apply cold compresses or cold cabbage leaves, to express small amounts of milk for comfort and, to take acetaminophen or ibuprofen if needed for discomfort. In instances where the weaning process is conducted in a gradual manner, the occurrence of engorgement is deemed to be improbable. A range of weaning strategies have been developed, including the reduction of breastfeeding sessions (at an interval of 2–5 days), shortening of each breastfeeding session, and extension of the time between breastfeeding sessions. Midday feeding is frequently considered optimal for this purpose, as infants tend to be more active during this period and may be less inclined to become fussy. It has

been hypothesized that alternative feeding arrangements may be more successfully implemented by individuals other than mothers [32].

3.8 Nipple and breast pain

The etiology of nipple and breast pain can be categorized as follows: nipple injury sustained during breastfeeding (e.g., improper latch or suction) or pumping (e.g., due to a poorly fitted breast shield), nipple vasoconstriction, engorgement, narrowed (blocked) ducts, nipple and breast infections, excess milk production, and nipple dermatitispsoriasis. It is imperative that an episode of breastfeeding be observed since the majority of cases of breast pain in lactating mothers are attributable to incorrect breastfeeding techniques. Latch and feeding techniques should be assessed directly [32].

3.8.1 Nipple injury

Nipple injuries are characterized by nipple pain, abrasion, bruising, cracking, and/or blistering. The underlying cause is most often inadequate breastfeeding techniques. It is imperative that women with nipple injury undergo a comprehensive evaluation that encompasses an assessment of their breastfeeding technique and an investigation into the potential presence of an underlying nipple condition. It is imperative to differentiate between pain resulting from nipple injury and that arising from nipple sensitivity, which peaks on the fourth postpartum day before subsiding [32].

3.8.2 Areolar dermatitis

Eczema and psoriasis of the nipple/areolar complex can present as pruritic and painful burning sensations in the areola and nipples, accompanied by a red, scaly rash. This phenomenon is more prevalent among women with a medical history of either of these two skin conditions. Other factors that have been identified as contributing to the condition include irritant dermatitis, which can be triggered by soaps or fragrances, solid foods introduced into the infant's diet, and allergic reactions to topical treatments [32].

3.8.3 Engorgement

Several interventions may be employed to alleviate the symptoms of engorgement. Such measures may include the application of cool compresses, manual expression of breast milk, and the use of analgesics. However, there is a paucity of data regarding their comparative efficacies [32].

3.8.4 Narrowed (blocked) ducts

The primary management strategy for a blocked milk duct involves the implementation of regular on-demand feeding in conjunction with effective pumping techniques. This approach aims to ensure effective milk drainage while simultaneously avoiding excessive pumping and complete emptying of the breast. A range of interventions have been identified, including the application of gentle manual stimulation to the breast to express breast milk and the use of cold compresses. Unrelieved ductal narrowing has been shown to result in lactational mastitis [32].

3.9 Breast infections

3.9.1 Lactational mastitis

Lactational mastitis is defined as localized inflammation of the breast that is associated with breastfeeding. The presentation of the condition is typically a firm, red, tender area of one breast. In the early stages of breast infection, the presentation can be subtle with few clinical signs, whereas patients with advanced infection may present with a large area of breast swelling with overlying skin changes. Systemic symptoms include fever, malaise, and flu-like symptoms. Although the occurrence of mastitis is not confined to a specific time during lactation, it is most prevalent during the first 3 months postpartum. The primary event appears to be ductal narrowing, which leads to poor drainage and subsequent inflammation, edema, and compression of the additional milk ducts. This condition is typically associated with breastfeeding difficulties that result in prolonged engorgement or inefficient milk drainage. Such difficulties may include partial blockage of milk ducts, inadequate milk removal, infrequent feeding, nipple trauma, or pressure on the breast. Engorgement has been demonstrated to exacerbate this problem; therefore, it is recommended that the breast is not fully emptied by the patient and that the use of a breast pump is avoided. Incomplete breast emptying has been demonstrated to result in the growth and proliferation of organisms, which can lead to the development of infectious mastitis [32].

3.9.2 Breast abscess

A breast abscess is defined as a localized collection of pus within the breast tissue, often preceded by the condition known as mastitis. The prevalence of this problem is low, with a reported incidence of 0.1 percent. However, this figure increased to 3 percent among the women with antibiotic-treated mastitis. The presentation of breast abscess is frequently comparable to that of mastitis, manifesting as breast discomfort and systemic symptoms, but with the additional presence of a fluctuant, tender, palpable mass. It is important to note that breast abscesses may also occur in the absence of fever or breast redness [32].

3.9.3 Candidal infection

A significant proportion of women diagnosed with "candidal" infection present with symptoms including sore nipples, often accompanied by deep, sharp shooting and/or burning pains in the breasts. These symptoms occur frequently in conjunction with infant thrushes. The diagnosis of mammary candidiasis is generally made on the basis of clinical findings, with the following factors being taken into consideration: the presence of breast pain that is disproportionate to the physical findings, history of infant oral or diaper candidal infection, maternal vaginal candidal infection, physical findings of shiny or flaky skin of the affected nipple, positive skin scraping of nipple or areolar region demonstrating Candida, or positive breast milk culture for Candida [32].

3.9.4 Management

The treatment of breast infections involves the administration of appropriate antibiotics or antifungals and drainage of the abscess, if deemed necessary.

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Section 3

Breastfeeding Challenges and Lactation Realities in Latin America

Chapter 6

Impact of Gestational Diabetes Mellitus on Breastfeeding Outcomes and Evidence-Based Strategies for Enhancement

Merve Küçükoğlu Keser and Sıddika Songül Yalçın

Abstract

Gestational diabetes mellitus (GDM) is a major global health concern linked to various metabolic risks and adverse breastfeeding outcomes. Mothers with GDM often experience delayed breastfeeding initiation, lower rates of exclusive breastfeeding, and shorter breastfeeding durations compared to non-GDM mothers. These difficulties are influenced by both maternal and neonatal factors, such as insulin resistance, obesity, cesarean delivery, neonatal hypoglycemia, delayed lactogenesis, and mother-infant separation. Psychological stress and misconceptions about breastfeeding with diabetes further hinder breastfeeding success. To address these challenges, evidence-based interventions include prenatal education, emotional support, enhancing lactogenesis, and correcting false beliefs. Professional lactation guidance and weight management are also essential. A multidisciplinary approach is recommended to overcome both physiological and psychological barriers. Such efforts can improve breastfeeding rates and support long-term health for mothers and their infants. However, further research is needed to establish standardized breastfeeding support guidelines tailored to this population. This chapter outlines the impact of GDM on breastfeeding, highlights the associated challenges, and presents evidence-based strategies to promote better breastfeeding outcomes in mothers with GDM.

Keywords: gestational diabetes mellitus, breastfeeding, breast milk, breastfeeding support, lactogenesis

1. Introduction

Gestational diabetes mellitus (GDM) is a global health issue that is increasingly prevalent and has been shown to be associated with both short- and long-term metabolic problems [1]. First defined by the World Health Organization (WHO) in 1965, GDM refers to any level of glucose intolerance that is initially identified during pregnancy, regardless of whether the condition persists postpartum [2]. From a pathophysiological perspective, GDM is characterized by pancreatic β-cell dysfunction and a reduction in function due to the increased insulin requirements during pregnancy,

Development stage	Situation	Estrogen	Progesterone	Prolactin	Oxytocin	Cortisol	Insulin	Thyroxine	Parathyroid hormone	Growth hormone	Epithelial growth factor
Mammogenesis	Development of breasts to a functional state	↑	↑	↑		↑				↑	↑
Lactogenesis I–II	Synthesis and secretion of milk from the breast alveoli	↓	↓	↑		↑	↑				
Galactokinesis	Ejection of milk outside the breast	↓	↓	↑		↑	↑				
Galactopoiesis	Maintenance of lactation	↓	↓	↑	↑	↑	↑	↑	↑		
Involution	Regression and atrophy post lactation	↓	↓	↓	↓						

Table 1.
Lactation physiology [15–17].

leading to insulin resistance and elevated glucose levels [3]. GDM has been associated with various complications during pregnancy and delivery, and it has been shown to be linked with certain long-term health risks [4]. In addition to these risks, GDM can negatively affect breastfeeding success [5–7]. A common finding across studies is that mothers with GDM are less likely to exclusively breastfeed their infants compared to mothers without GDM, and the total duration of breastfeeding is generally shorter in the GDM group [8–10]. Prenatal exposure to maternal diabetes has been linked to variations in early infant suckling behaviors. Research indicates that infants born to mothers with insulin-treated GDM exhibit fewer sucks and bursts within a 5-minute period compared to those whose mothers managed GDM through dietary measures or those born to nondiabetic mothers [11].

The WHO recommends initiating breastfeeding within the first hour after birth, continuing exclusive breastfeeding for the first 6 months, and maintaining breastfeeding alongside appropriate complementary foods for at least 2 years. Despite these guidelines, global breastfeeding rates remain below the desired targets. One of the key goals is to increase the rate of exclusive breastfeeding during the first 6 months to at least 50% by 2025 [12]. Successful breastfeeding is achievable by implementing the "10 Steps to Successful Breastfeeding" outlined by UNICEF and WHO [13]. Successful breastfeeding should be infant-led and involve exclusive breastfeeding [12, 14].

Breastfeeding success can be better understood through a comprehensive examination of lactation physiology (**Table 1**). GDM is known to be particularly associated with the delayed onset of lactogenesis II [18]. GDM has been shown to cause delays and disruptions in various stages of lactogenesis, ultimately affecting the breastfeeding process [7, 19]. Therefore, healthcare professionals should be well-informed about the risk factors involved and implement appropriate evidence-based interventions to support successful breastfeeding outcomes (**Table 1**).

2. Effects of GDM on breast milk composition

2.1 Carbohydrates

GDM may induce subtle alterations in the carbohydrate composition of breast milk. Several studies have reported that colostrum from mothers with GDM exhibits significantly higher concentrations of total sugars compared to that of nondiabetic mothers [20]. Nonetheless, the evidence on milk carbohydrates is conflicting. In one study, lower lactose concentrations were reported in colostrum from mothers with GDM compared to controls, although glucose levels were similar. The same study also noted that in transitional milk (approximately 1–2 weeks postpartum), there were no significant differences in total carbohydrate content between GDM and non-GDM mothers [21].

2.2 Fats and energy

The effect of GDM on milk fat content and energy density appears to be influenced by the stage of lactation. In the colostral and early transitional phases, the majority of studies have reported no significant differences in total fat content between mothers with GDM and their nondiabetic counterparts [21]. In contrast, differences in milk composition may become apparent in the mature stage of lactation. wreduced fat content and consequently lower caloric density in their mature

milk compared to nondiabetic controls [22]. These findings are consistent with clinical observations suggesting that the fat and energy content of mature milk may be reduced in diabetic mothers. However, not all studies report concordant results. At least one investigation utilizing mid-infrared milk analysis reported higher energy content in breast milk from GDM mothers across various stages of lactation [21]. Methodological differences—such as the timing of sample collection and handling procedures—are likely contributors to these inconsistencies.

2.3 Proteins

Total protein concentrations in breast milk appear to remain relatively stable between mothers with and without GDM, particularly during the early postpartum period. Multiple studies have consistently demonstrated that colostral protein content does not significantly differ according to maternal GDM status [21]. As lactation progresses, findings on protein concentrations in breast milk remain inconclusive. While one study reported reduced protein levels in both transitional and mature milk of mothers with GDM, other studies—including that by Shapira et al.—did not observe significant differences in later milk stages [21, 22]. Taken together, these data suggest that the macronutrient composition of human milk—including proteins, fats, and lactose—is largely comparable between mothers with and without GDM during the colostral and early transitional phases. Minor variations have been documented in some studies, such as elevated sugar levels in colostrum and modestly reduced fat and caloric content in mature milk from GDM mothers [20, 22].

2.4 Bioactive molecules and immune components

GDM is associated with significant alterations in the hormonal and metabolic profile of human milk. A longitudinal study involving 96 participants demonstrated that insulin levels were significantly higher in both colostrum and mature milk from GDM mothers compared to those of normoglycemic controls. Adiponectin, an insulin-sensitizing and anti-inflammatory hormone, is consistently found at lower concentrations in the milk of GDM mothers. In the same longitudinal cohort, colostral adiponectin levels were approximately 30–40% lower in GDM mothers compared to controls, and this reduction persisted in mature milk at 3 months postpartum. Ghrelin, a hormone involved in appetite regulation, is also found at reduced levels in the breast milk of mothers with GDM in both colostrum and mature milk compared to nondiabetic controls. Conversely, leptin—another key hormone involved in appetite regulation—appears to be more strongly associated with maternal adiposity than with GDM status itself. The same study has reported that breast milk leptin levels correlate closely with maternal body mass index (BMI), and when controlling for adiposity, GDM does not consistently influence leptin concentrations in either colostrum or mature milk [23].

GDM alters the immunological composition of colostrum, promoting a pro-inflammatory cytokine profile. Studies have shown that colostrum from GDM mothers contains elevated levels of pro-inflammatory mediators such as interferon-gamma (IFN-γ), interleukin-6 (IL-6), interleukin-15 (IL-15), tumor necrosis factor-alpha (TNF-α), and interleukin-8 (IL-8), alongside reduced concentrations of anti-inflammatory or regulatory factors like interleukin-1 receptor antagonist (IL-1ra) and granulocyte-macrophage colony-stimulating factor (GM-CSF). These alterations suggest a shift toward an inflammatory immune signaling environment. Such changes

in breast milk may serve as bioactive signals influencing neonatal immune development, growth, and appetite regulation in the early postnatal period [24].

In addition to cytokine alterations, studies have explored classical immune components in the breast milk of mothers with GDM. While total secretory IgA (sIgA) levels in colostrum appear comparable between GDM and non-GDM mothers, qualitative differences emerge by the transitional milk stage. Specifically, diabetic mothers have been found to produce milk with reduced total IgA protein content and altered sIgA glycosylation patterns. Since glycosylation influences IgA's microbial binding and resistance to degradation, these modifications may impair its protective functions in the infant gut [21].

GDM primarily affects the functional quality rather than the absolute concentrations of key immunological proteins in breast milk. Although total lactoferrin and IgA levels in transitional milk are comparable between GDM and non-GDM mothers, GDM is associated with altered glycosylation patterns, which may impair their antimicrobial and immunoregulatory functions. Additionally, increased levels of dermcidin and lipocalin-matrix metalloproteinase-9 (NGAL-MMP-9) complexes in GDM colostrum point to an enhanced innate immune response in the mammary gland. Proteomic studies further reveal differential expression of numerous immune and nutritional proteins in GDM milk. Collectively, these findings suggest that GDM alters the immune composition and post-translational modifications of breast milk, with potential implications for neonatal immune development and microbial colonization [21].

2.5 Breast milk microbiota

The breast milk microbiota, which plays a role in shaping the infant gut microbiome, may be influenced by GDM, though current findings are inconsistent. A large study reported increased microbial diversity and altered bacterial composition in the milk of GDM mothers, suggesting that maternal metabolic dysregulation affects microbial communities [25]. However, another smaller study found no significant differences in microbial diversity or composition between GDM and non-GDM milk [26]. These conflicting results imply that any GDM-related changes to the milk microbiome may be subtle or dependent on factors such as maternal BMI, diet, or sampling time. Nonetheless, given the influence of breast milk bacteria on infant gut colonization and immune development, further research is warranted to clarify the potential impact of GDM.

3. Risk factors and pathophysiology for breastfeeding difficulties

Several risk factors contribute to breastfeeding difficulties in women with gestational diabetes. These risk factors, identified through various studies, are outlined in **Figure 1**.

In diabetic mothers, the higher prevalence of obesity and related complications, increased rates of cesarean (C/S) deliveries, the likelihood of infants being born with low birth weight or macrosomia, and a greater probability of the newborns requiring intensive care can all explain breastfeeding challenges [27–30]. Exclusive breastfeeding is less common in mothers with GDM compared to mothers without GDM. This could be attributed to factors such as insulin resistance, impaired cell function, hormonal changes, and genetic predisposition in these mothers [31–34]. In the short

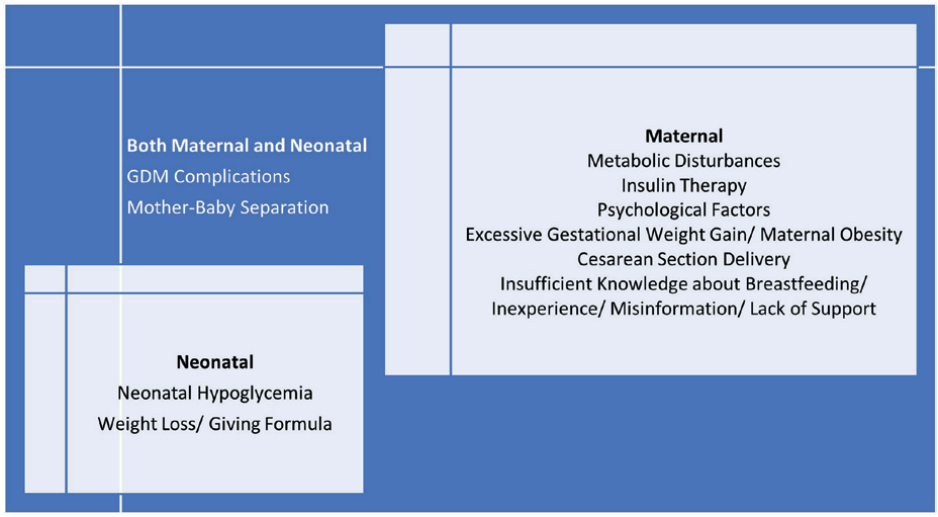

Figure 1.
Risk factors for breastfeeding difficulties in cases with GDM.

term, it is predictable that breastfeeding difficulties may arise due to the higher risk of postpartum complications and the increased need for special care in infants born to mothers with GDM [35].

3.1 Maternal risk factors

3.1.1 Metabolic disturbances

Delayed lactogenesis refers to the delay in milk production that lasts longer than 72 hours after delivery [36]. Hyperglycemia during pregnancy can alter breast tissue development and milk composition, leading to delayed lactogenesis and a reduction in milk supply [36]. Insulin resistance can impair prolactin secretion and hinder milk production, making it more challenging to initiate and sustain breastfeeding [37]. A study conducted in Spain showed that mild impaired glucose tolerance might be a risk factor for early cessation of breastfeeding [38].

3.1.2 Insulin therapy

A recent study indicated that, regardless of the treatment approach, breastfeeding problems were reported in GDM cases [39]. Another study found that insulin therapy, along with obesity, was a major risk factor for early breastfeeding failure and inadequate breastfeeding during hospitalization [40]. A 2011 review by Üstün et al. reported that treatment types in GDM influence outcomes, with insulin-using mothers experiencing more breastfeeding problems [41, 42].

3.1.3 Psychological factors

The emotional burden associated with GDM alone is a risk factor for breastfeeding failure [43]. Furthermore, misconceptions or a lack of understanding about GDM may negatively influence breastfeeding practices [44]. A population-based study

conducted in 2013 found that GDM mothers receiving insulin therapy had lower breastfeeding intentions compared to the control group [45].

In 2017, Tokat et al. investigated the impact of GDM on breastfeeding outcomes and self-efficacy perception. They found that healthy mothers had higher breastfeeding self-efficacy scores [46].

3.1.4 Excessive gestational weight gain and maternal obesity

Obesity rates are higher in mothers with GDM compared to the healthy population [47, 48]. It has been suggested that pre-pregnancy obesity interferes with breast development during pregnancy, alters the prolactin response, delays the onset of lactogenesis, and leads to improper positioning, latching, and early cessation of breastfeeding [49]. Obese mothers may struggle with holding their baby, which can lead to early cessation of breastfeeding [50, 51].

3.1.5 Cesarean section delivery

The rate of C/S deliveries is higher in pregnancies with GDM compared to healthy pregnancies [52]. C/S delivery alone is a risk factor that decreases breastfeeding rates [53].

3.1.6 Insufficient knowledge about breastfeeding/inexperience/misinformation/lack of support

Due to the numerous challenges that mothers with GDM may face during the postpartum period, hospital conditions may fail to provide adequate breastfeeding support. Poor latch due to a lack of breastfeeding knowledge can cause pain during breastfeeding, hindering the desire and ability to continue breastfeeding [54]. Some diabetic mothers may avoid breastfeeding, fearing that diabetes could be transmitted to the baby [55].

It is well known that mothers with GDM initiate breastfeeding later than those without GDM [42, 45, 56]. When comparing primiparous and multiparous GDM mothers, those with previous breastfeeding experience tend to start breastfeeding earlier, while a lack of experience poses a risk for delayed initiation [57]. A qualitative study conducted in the U.S. in 2015 interviewed mothers with GDM and found that associated conditions directly impacted their ability to start and maintain breastfeeding. Some mothers reported that professional support was insufficient, and others mentioned that concerns about the baby's hunger led family members to recommend formula feeding [58].

3.2 Neonatal risk factors

3.2.1 Hypoglycemia

Newborns of diabetic mothers are more likely to experience hypoglycemia in the first 24 hours compared to other infants. This increases the likelihood of the baby needing admission to neonatal intensive care and can interfere with breastfeeding [59]. Additionally, due to the higher risk of macrosomia, the incidence of hypoglycemia is also higher in these babies [60, 61].

In symptomatic hypoglycemic babies, poor sucking and weak crying may be observed [62], which can delay breastfeeding further and worsen hypoglycemia. Early breastfeeding is an effective approach to prevent hypoglycemia [63].

3.2.2 Weight loss/giving formula

Infants born to mothers with GDM have been reported to experience challenges related to weight gain in the postpartum period [64]. In general, infants fed breast milk lose less weight during the first days postpartum compared to those fed formula [65]. Babies of mothers with GDM tend to lose more weight than those in the healthy population. When mothers with GDM supplement breastfeeding with formula due to concerns about their baby not being full, it can disrupt breastfeeding and lead to early cessation.

3.3 Both maternal and neonatal risk factors

3.3.1 GDM complications

Obstetric complications in GDM are risk factors for both mothers and neonates. Even when the desire to breastfeed is strong, the obstacles encountered along the way can affect the success of initiating and maintaining breastfeeding [42]. Studies have shown that infants born to mothers with GDM may experience spontaneous abortion and major congenital anomalies [66, 67]. Excessive fetal growth in the second and third trimesters can lead to birth trauma, shoulder dystocia, neonatal hypoglycemia, hyperbilirubinemia, polycythemia, and even stillbirth [68]. The presence of complications directly negatively impacts breastfeeding success [69].

3.3.2 Mother-baby separation

In the event of obstetric or neonatal complications after birth, mother-baby separation may occur. This can lead to neonatal hypoglycemia, which may result in formula feeding. Such separation directly negatively impacts breastfeeding success [13, 27–30].

4. Strategies to ensure breastfeeding success

Breastfeeding success in mothers with GDM should be supported with a tailored approach during both pregnancy and the postpartum period. Initially, comprehensive breastfeeding education should be provided to these mothers during the prenatal period. These education sessions should cover breastfeeding physiology, successful techniques, and potential challenges that mothers with GDM might face, which will help increase their knowledge and self-confidence. This preparation and awareness can positively influence their motivation to begin breastfeeding.

In addition to breastfeeding support, pharmacological treatments in cases of GDM should also be carefully reviewed. Some women with GDM can manage their blood sugar levels through diet alone, but others, including those with pregestational type 2 diabetes and all individuals with type 1 diabetes, require medical treatment [70]. The standard treatment for pregestational diabetes is insulin [71]. Since insulin is a large molecule, it is unlikely to pass into breast milk through simple diffusion [72]. A small study (N = 14) involving mothers with type 1 diabetes (N = 4), type 2 diabetes (N = 5), and without diabetes (N = 5) found similar levels of insulin in the breast milk of all three groups [73]. Additionally, higher insulin levels in breast milk have been linked to lower infant weight-for-length z-scores at 4 months and 1 year [74].

Glyburide and metformin are two oral medications commonly used to manage GDM and pregestational type 2 diabetes. Glyburide appears to enter breast milk at very low levels. It is classified as compatible with breastfeeding, though infants should be monitored for signs of low blood sugar [75]. Metformin, a biguanide that helps reduce insulin resistance, is present in breast milk in minimal amounts and is considered safe for breastfeeding, although extra caution is recommended for premature infants or those with kidney issues [75]. The Endocrine Society advises that women with overt diabetes continue taking metformin or glyburide while breastfeeding (strong recommendation, high-quality evidence) [76].

Metformin has been suggested as a potential galactagogue due to its influence on insulin resistance, which may contribute to low milk production. It is derived from guanidine, a compound found in *Galega officinalis*, also known as goat's rue, a plant recognized for its milk-boosting effects in goats. In a randomized controlled trial (RCT) involving pregnant women with polycystic ovary syndrome (PCOS), those who were given metformin experienced a slightly longer duration of exclusive breastfeeding compared to those who did not (4.5 vs. 3.9 months, $p = 0.08$). A small pilot study ($N = 15$) assessed the effects of postpartum metformin for women with insulin resistance and low milk supply, finding a modest increase in milk production in the metformin group, while the placebo group showed a decrease. The median changes in milk production were +22 mL/24 hours (range −5 to 54) for metformin users and −58 mL/24 hours (range −83 to 1) for placebo users ($p = 0.07$) [77]. These findings support the idea that managing insulin resistance may help improve milk supply, though the increase in production was modest.

4.1 Emotional support

Given that a GDM diagnosis may create stress and anxiety in mothers, providing psychological support can have a positive impact on breastfeeding. Counseling services during both pregnancy and the postpartum period can help balance the mother's psychological state and strengthen breastfeeding motivation. Additionally, support groups with other mothers who are experiencing similar situations can increase feelings of security during the breastfeeding process.

Emotional support in the first 6 months has been shown to increase exclusive breastfeeding rates [78]. Studies from various regions of the world have demonstrated that breastfeeding support over time significantly improves breastfeeding rates among mothers. Midwives, nurses, and other healthcare professionals should be aware of the negative impact that GDM can have on breastfeeding outcomes and provide appropriate support. Ensuring skin-to-skin contact, promoting mother-infant bonding, and offering additional support for mothers experiencing breastfeeding difficulties can reduce breastfeeding issues [57]. This practice plays a crucial role in initiating breastfeeding, accelerating lactogenesis, and stimulating milk production. Especially in cases where the newborn may be at risk for hypoglycemia, this contact will effectively support both breastfeeding success and the baby's blood sugar regulation.

4.2 Supporting lactogenesis

Considering that the hormonal effects of GDM can delay lactogenesis, the frequency of breastfeeding should be increased, and techniques such as hand expression or pump use should be encouraged to stimulate milk production. Mothers should be

taught appropriate techniques to facilitate this process. Relaxation methods (such as massage and warm compresses) can also stimulate the release of prolactin and oxytocin, enhancing milk production.

4.3 Correcting misconceptions

Some mothers may believe that GDM can be transmitted to the baby through breastfeeding. Such misconceptions should be addressed through accurate information. Scientific evidence explaining the relationship between diabetes and breastfeeding, as well as the protective effects of breastfeeding for the baby, can ensure that mothers have access to the correct information.

4.4 Breastfeeding support

In the postpartum period, breastfeeding success should be supported through follow-up by a professional healthcare worker. These follow-ups should include teaching proper breastfeeding positions and techniques to minimize potential challenges. Additionally, home visits or phone support from lactation consultants or breastfeeding specialists can play an important role in providing the necessary information and support. Extended breastfeeding is linked to a lower risk of gestational diabetes progressing to type 2 diabetes and a decreased incidence of type 2 diabetes in women who had normal glucose levels during pregnancy [79]. These findings highlight the value of promoting breastfeeding as a health strategy for women.

4.5 Supporting obesity management

Conditions such as obesity in mothers with GDM may make breastfeeding positions more challenging and hinder the breastfeeding process. Therefore, offering nutritional counseling for healthy weight management postpartum can facilitate the breastfeeding journey.

4.6 Cesarean section recovery

Since mothers with GDM often have higher rates of C/S deliveries, providing information on pain management and proper breastfeeding positions in the cesarean section recovery period is essential. Teaching C/S mothers techniques for breastfeeding in bed and providing supportive equipment can ease the process.

5. Conclusion

Ensuring successful breastfeeding in mothers with GDM requires a tailored, multidisciplinary approach that spans both the antenatal and postpartum periods. Providing comprehensive breastfeeding education, including information on breastfeeding physiology, techniques, and potential challenges specific to GDM, can empower mothers with the knowledge and confidence to initiate and maintain breastfeeding. Emotional support, particularly in the first 6 months, is critical to improving breastfeeding outcomes and should be integrated into care plans. This support, alongside counseling services to address anxiety and stress associated with GDM, helps mothers feel more secure in their ability to breastfeed.

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In addition, promoting effective lactogenesis through increased breastfeeding frequency, hand expression, or the use of pumps can aid milk production, while relaxation techniques such as massage and warm compresses can further stimulate prolactin and oxytocin release. Correcting misconceptions about the transmission of diabetes through breastfeeding and providing evidence-based information can ensure mothers have the correct understanding and confidence to breastfeed.

Follow-up care by healthcare professionals, including proper guidance on breastfeeding positions and techniques, is essential to prevent and manage potential difficulties. Furthermore, offering nutritional counseling for postpartum weight management and addressing the specific needs of mothers recovering from C/S will further support breastfeeding success. Collectively, these strategies can significantly improve the breastfeeding experience for mothers with GDM, promoting better maternal and infant health outcomes.

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Chapter 7

Breastfeeding Challenges

Şerife Suna Oğuz and Merve Kahyaoğlu

Abstract

Breastfeeding is, in fact, the result of a life struggle; it is essential for the mother to maintain her own homeostasis and to connect another being to life. In this regard, breastfeeding represents one of the most powerful and beautiful examples of nature's effort to ensure the continuity of life. However, the breastfeeding process carries inherent challenges, which are often shaped by maternal, neonatal, and environmental factors. A mother's sense of self-efficacy is one of the most critical components of this process, and the strength of this feeling plays a significant role in the successful completion of the breastfeeding experience. In some high-risk pregnancy groups, such as mothers with gestational diabetes, a low sense of self-efficacy may further complicate the process. This situation also increases the risk of these mothers encountering health problems such as obesity and type 2 diabetes in the future, turning it into a public health issue. Therefore, raising awareness about the breastfeeding process is essential, and specialized support mechanisms should be developed for this group of mothers. The challenges encountered during breastfeeding can often be overcome by identifying the root causes and applying appropriate solutions. Globally, various codes have been implemented to promote breastfeeding, with 53 countries currently adhering to these codes. The widespread establishment of baby- and mother-friendly hospitals plays a key role in easing the challenges of breastfeeding and ensuring the sustainability of this miraculous process.

Keywords: breastfeeding challenges, self-efficacy, gestational diabetic mothers, lactation problems, improving policies

1. Introduction

The leading success for breastfeeding is influenced by the mother, the baby, and the environment surrounding them. So, this makes breastfeeding susceptible to various risk factors. Maternal, neonatal, and environmental factors represent interconnected challenges, each influencing the success of breastfeeding. Overcoming these intertwined obstacles is essential for achieving optimal breastfeeding outcomes. This part aims to discuss frequently reported breastfeeding issues encountered in clinical practice and provides guidance on overcoming these barriers to support successful lactation.

2. Risk factors for breastfeeding

The mother, the baby, and their environment surrounding them are factors that directly affect the success of breastfeeding. Therefore, there are many risk factors that can reduce the success of breastfeeding [1].

2.1 Maternal risk factors in breastfeeding

2.1.1 Maternal age

When talking about maternal risk factors, we can observe that the mother's age in both ends is an important factor for breastfeeding. Being a mother in the adolescent age means encountering a mother who is not ready to have a responsibility for a child on her own. These mothers tend to have lower self-efficacy and require more breastfeeding support. On the other hand, advanced maternal age group mothers can increase the risk of existing congenital anomalies and may negatively impact the breastfeeding process due to the higher risk of developing chronic diseases during pregnancy [2].

Supporting adolescent mothers is somewhat like a double-edged sword. The primary goal is to encourage breastfeeding for the baby, but if successful, this can inadvertently lead to increased pressure on the adolescent mother and her environment to have children at younger ages, potentially leading to broader societal issues. Therefore, support for these groups should be provided with great care and consideration. Additionally for all ages, public support should be provided, pregnancy education should be more widespread, and accurate information must be shared [3].

2.1.2 Previous failed breastfeeding experiences

A mother's previous experience with unsuccessful breastfeeding is another risk factor affecting breastfeeding success in the next pregnancy. This hits on the self-efficacy of breastfeeding, and it can have connection between postpartum depression [4].

Actually, in baby-friendly hospitals, there is a lot of information that mothers can access to boost their self-efficacy, so it is really important for the mother to receive clear information, especially due to her previous unexpected experiences. Prenatal education and breastfeeding counseling services are crucial at this point [5].

2.1.3 Unwanted pregnancies

Unplanned or unwanted pregnancies can make it difficult for mothers to focus on the breastfeeding process both psychologically and physically, which can negatively impact breastfeeding success. Studies have shown that the desire fathers feel regarding pregnancy and the support they provide to their partners affect the mother's emotional state and help prolong the breastfeeding period [2].

2.1.4 Is breast milk really insufficient?

The belief in insufficient breast milk can lead to unnecessary formula use, significantly reducing breastfeeding rates. High literacy rates, availability of environmental support, and receiving proper breastfeeding counseling can help overcome such negative beliefs and encourage a solution-focused approach. As a result, the mother will move away from unhealthy thoughts and experience a positive breastfeeding journey. If there is an issue with breast milk production, it should be diagnosed by specialists such as neonatologists, pediatricians, family physicians, lactation consultants, and nurses. The mother should not make this decision on her own [1, 6].

For example, some chronic conditions can affect lactation, such as preeclampsia, gestational diabetes, HELLP syndrome, and so on. These individuals should receive a focused approach and be fully informed about the condition they are experiencing [1, 6].

2.1.5 Perinatal events and coexisted chronic diseases

Perinatal complications, mothers with high-risk pregnancies, and those who experience complications during pregnancy may be affected both psychologically and physiologically during the breastfeeding process, leading to a decrease in breastfeeding rates [2].

For example, a woman diagnosed with preeclampsia has an increased likelihood of delivering a premature baby, which may require intensive care. The need for intensive care can create a barrier to breastfeeding and skin-to-skin contact [2].

As another example, hypothyroidism can affect hormonal balance, which may lead to impaired prolactin secretion and a delay in the second stage of lactogenesis. Due to the deficiency of thyroid hormones, the mother may become more prone to depression, which can affect the breastfeeding in a negative way [7].

Additionally, due to a delay in the second stage of lactogenesis, milk production may be delayed in other perinatal complications (antepartum, intrapartum, and postpartum), such as gestational diabetes mellitus, hypertension, prematurity, twins, placental problems, early or late neonatal sepsis, low birth weight, fetal distress, macrosomia, and cesarean delivery, general anesthetics, and pain killer use. Due to these conditions, it is more difficult to establish effective breastfeeding [2].

2.1.6 Early return to work requirement/desire

Employed mothers may sometimes need to return to their jobs earlier due to socioeconomic reasons or personal desires. In such cases, a lack of sufficient time for breastfeeding can weaken the bond between the mother and baby, and breastfeeding rates may decrease. Flexibility in working hours for breastfeeding mothers and the provision of support such as baby care or breastfeeding rooms at workplaces should be encouraged. These types of support allow mothers to continue their breastfeeding journeys in a more manageable and healthy way [2].

2.1.7 Chronic medication use and substance abuse

Breastfeeding mothers may need to use certain groups of medications due to their current health conditions. In this case, it is important for mothers to consult their healthcare providers to understand the relationship between the medications and breastfeeding, as well as how they transfer into breast milk. If possible, treatment should be switched to an alternative medication compatible with breastfeeding under the supervision of the doctor. However, if a change of medication is not possible, the pediatrician and relevant specialists should jointly decide on the duration of any restrictions on breastfeeding. The mother should not manage this process on her own [1].

Some mothers may struggle with smoking, alcohol, or substance addiction. Nicotine inhibits prolactin production, which negatively affects breast milk production, so it is important for mothers who smoke to develop strategies for quitting to avoid difficulties during breastfeeding [8].

Mothers with alcohol and substance abuse issues should seek treatment at institutions that deal with alcohol and substance abuse to monitor their treatment process [8].

Breastfeeding should not begin until substance abuse treatment is complete, which naturally impacts breastfeeding success. Babies born to mothers with addiction issues

should be closely monitored, especially during the first week of life, for neonatal withdrawal syndrome. If the mother continues her addiction, immediate notification to social services is necessary to minimize harm to the baby [8, 9].

2.1.8 Postpartum depression

During the postpartum period, mothers may experience emotional confusion, and it is crucial for them to receive support during this time. Postpartum depression is a form of depression that starts after childbirth and is characterized by symptoms such as crying, feelings of helplessness, guilt, fatigue, loss of appetite, difficulty concentrating, sleep problems, and struggling to cope with the baby, without involving psychosis. Mothers diagnosed with postpartum depression often experience a decrease in breastfeeding rates [10].

In such situations, providing psychosocial support and motivation is essential. Ensuring that the mother does not feel isolated and that she does not spend too much time alone with her baby will help her navigate this challenging period more easily [10].

2.1.9 Breastfeeding self-efficacy and self-efficacy with GDM mothers

Breastfeeding self-efficacy refers to a mother's confidence in her ability to breastfeed, the level of effort she is willing to invest, her thoughts about breastfeeding, and her ability to overcome emotional challenges throughout the breastfeeding journey. This concept plays an essential role in the start and persistence of breastfeeding. While several factors can impact self-efficacy, it is widely recognized that mothers with higher self-efficacy are more likely to have higher breastfeeding success rates [10].

The mother's breastfeeding self-efficacy is influenced by four main factors:

1. Breastfeeding experiences
2. Observed examples from the environment
3. Family, friends, and social support
4. The mother's psychosocial condition [11].

A mother who lacks accurate or sufficient information about managing gestational diabetes mellitus (GDM) may have a negative impact on her psychosocial condition, which can subsequently reduce breastfeeding success [6].

In a systematic review and meta-analysis study, many women reported difficulties in adopting new habits to manage GDM. Moreover, a general misconception about the effects of GDM was observed; some women believed that GDM would be transmitted to their babies through breastfeeding [12].

Koh and colleagues, through a recent cross-sectional telephone survey on women with a history of GDM, identified physical activity and psychosocial factors that influence participation in health activities. Women with higher social support (from significant individuals or family members) and self-efficacy were more likely to participate in physical activity. However, the study generally found a low prevalence of physical activity [13].

2.1.10 Breast-related issues

Problems with the breast due to anatomical, infectious, surgical, or accident-related causes can result in ineffective breastfeeding [1, 14].

For example, mothers who have had breast surgery in the past may experience difficulty breastfeeding due to tissue loss. These mothers should be provided with psychological support. If the other breast tissue is healthy, breastfeeding should be encouraged from the other breast. In cases where both breast tissues are lost, mothers should still be motivated, and it is indicated for mothers undergoing such processes to use breast milk substitutes [1, 4].

Mothers with an active breast infection (as examples: a breast abscess or herpes lesions) may be unable to breastfeed until the infection process is done. Additionally, nipple cracks caused by incorrect breastfeeding technique or sensitive breast tissue can also lead to significant difficulties with breastfeeding. These mothers should be checked to ensure they have learned the correct breastfeeding techniques, such as observing them while breastfeeding using scoring systems like the popular LATCH score. Nipple cracks are a major negative factor that can affect breastfeeding success. In this kind of situation with the doctor's recommendation, appropriate creams, cold compresses, and nipple protective pads can be used [4, 8].

Moreover, conditions related to the normal anatomy of the nipple may present challenges for breastfeeding, such as flat or inverted nipples, which is also related with the LATCH score. In such cases, mothers who do not receive proper breastfeeding guidance may struggle to manage these anatomical difficulties, leading to another challenge on breastfeeding. A mother with inverted or flat nipples will not be able to breastfeed effectively if she is unaware of methods to stimulate and protrude the nipple. So, when providing breastfeeding counseling, it is important to offer advice tailored to each mother, taking into account these anatomical structures [1, 8].

2.1.11 Assisted breastfeeding techniques and pacifiers

During the postpartum period, some mothers who face challenges with breastfeeding may resort to assisted breastfeeding methods. For example, mothers who struggle with manual milk pumping may use breast pumps. However, some studies suggest that the use of such devices may negatively affect breastfeeding success. These devices can weaken the milk flow between the mother and baby, potentially preventing effective breast emptying [15].

Additionally, with the use of nipple shields, since they do not resemble the mother's nipple exactly and the baby finds it easier to latch onto the shield, the baby may have difficulty transitioning back to the mother's nipple after using the device. This can lead to the baby becoming dependent on the shield and make the transition to natural breastfeeding more challenging. Other studies have observed that when nipple shields are used with premature infants, the amount of breast milk consumed during sucking increases, and they are beneficial for premature babies who have not fully developed sucking ability and cannot latch onto the nipple [15].

The use of bottles or pacifiers can lead to nipple confusion, creating significant barriers to the breastfeeding process. A bottle or pacifier could lead the mother from accurately noticing the baby's hunger cues. The feeding mechanism with a bottle or pacifier differs from the physiology of natural sucking, which may lead to improper jaw development. Furthermore, long-term use of bottles and pacifiers is known to contribute to tooth decay in later times [1, 4].

2.1.12 Obesity

Research has shown that obese mothers have lower breastfeeding continuity during the neonatal period compared to healthy mothers [2].

A study examining the milk content of these mothers found that pro-inflammatory biomarkers (SAA, CRP, TNF-α, IL-8, and IFN-γ) were at higher levels than the anti-inflammatory IL-10. As a result of inflammation, it is known that the mother's lactation process is also negatively affected by this condition [16].

Both pregestational obesity and gestational obesity are known to be linked to diabetes. Literature indicates that breastfeeding success in diabetic mothers is lower compared to healthy mothers. Factors such as delayed onset of lactation's second phase; inadequate milk production in the breast, particularly in mothers diagnosed with pregestational obesity; and low self-efficacy perception can negatively impact breastfeeding success [12, 17].

Therefore, monitoring weight during the prepartum period, healthy nutrition, and appropriate physical activities are undeniably important for the effect on breastfeeding [17].

2.2 Neonatal risk factors

2.2.1 Prematurity, low birth weight babies, and breastfeeding issues

The American Pediatric Association (APA) emphasizes that breast milk is the ideal product for the nutrition of premature infants. However, preterm birth can be a risk factor that may hinder the breastfeeding process. These babies often have insufficient sucking and swallowing abilities, and because they cannot latch onto their mothers effectively, successful breastfeeding may not be achievable. Premature infants are more prone to complications during the postnatal period, such as sepsis, intracranial hemorrhage, retinopathy of prematurity, feeding intolerance, necrotizing enterocolitis, and spontaneous intestinal perforation. These complications may require admission to the neonatal intensive care unit (NICU) and can prolong the baby's hospital stay. This separation between mother and baby may lead to delays in milk production. In both premature infants and those with low birth weight for their gestational age, the development of sucking and swallowing skills generally occurs later, and these infants require more nutrients due to their higher metabolic rate. As a result of such factors, breastfeeding issues may arise [18, 19].

2.2.2 Twins and breastfeeding

Breastfeeding one baby is a demanding process, so two of them can make it even more challenging. Research has shown that a mother can produce up to 2 kg of breast milk by the 6th month postpartum. Therefore, environmental and psychosocial support, breastfeeding counseling, and, as a result, the mother's self-efficacy in breastfeeding make effective breastfeeding possible for both babies. This leads the healthiest outcome for both the mother and the babies [20].

2.2.3 Latch-on problems to breast/ineffective sucking

If the baby does not latch onto the breast properly, effective breastfeeding cannot be possible. Premature babies or low birth weight infants (LBW), whose sucking and

swallow coordination is not fully developed, or healthy babies with mothers who have not received sufficient breastfeeding training, may latch incorrectly, which can lead to breastfeeding problems. A good breastfeeding observation plays a key role in this process as well. Knowing the main *reason* of ineffective sucking will help provide the *course* [4, 19].

2.2.4 Oral anatomical abnormalities and breastfeeding issues

Anatomical abnormalities in the baby's oral cavity, palate, and jaw structure can pose a barrier to effective breastfeeding. Conditions such as ankyloglossia or a short frenulum may lead to difficulties in properly latching onto the breast, and recognizing this during examination can help prevent breastfeeding issues. If the short frenulum is severe, it can be corrected through surgical intervention. Additionally, babies with a cleft palate or lip may struggle to latch and have difficulties with sucking. A pilot study conducted by Kaye et al. on children with cleft lip and palate examined the feeding methods chosen by mothers, revealing that 78% of mothers either breastfed directly or provided expressed breast milk. Additionally, it was found that these infants received breast milk for a duration of up to 4 months [21].

Also, according to these kinds of craniofacial abnormalities, the American Cleft Palate and Craniofacial Association recommends managing these patients with a multidisciplinary approach. These abnormalities should be managed by specialists in audiology, radiology/medical imaging, genetics/genetic counseling, neurology and neurosurgery, nursing, ophthalmology, plastic and reconstructive surgery, oral and maxillofacial surgery, orthodontics, otolaryngology, pediatric medicine, pediatric dentistry, psychology, social work, and speech-language pathology. A consensus should be reached to ensure the baby gains weight and receives breast milk in the most effective manner as soon as possible after correction [22].

Sometimes, these anatomical differences can also be part of a congenital disease. For instance, Beckwith-Wiedemann syndrome, characterized by macroglossia and a short frenulum, is an example of this [23].

2.2.5 Diseases

In the postnatal period, conditions that require treatment in the intensive care unit, such as respiratory distress, sepsis, or pathological jaundice, can create a barrier to effective breastfeeding. Neurometabolic diseases and congenital anomalies that affect neurocognitive processes can negatively impact the breastfeeding process too. At this point, a patient- and disease-based approach is necessary. Even if skin-to-skin contact with the mother cannot be established as much as possible, it is crucial to initiate feeding with breast milk immediately, provided the patient has oral tolerance [1, 17].

2.2.6 Sleepy baby

A newborn baby typically sleeps between 16 and 18 hours, but certain factors such as the mother undergoing general anesthesia during delivery, the baby's low birth weight leading to inadequate milk intake, inability to recognize hunger cues, incorrect latch, or jaundice can cause the baby to sleep more, resulting in breastfeeding issues. Among these factors, jaundice is particularly important due to its association with insufficient breast milk intake and pathological weight loss. It should be

recognized that breastfeeding with breast milk is a crucial point in preventing these issues. Correctly understanding the problem is essential for the procedure to proceed properly [1].

2.2.7 Baby born from a high-risk pregnancy

In pregnancies with high risk, babies are more likely to experience breastfeeding difficulties. For example, babies born to mothers with gestational diabetes mellitus (GDM) are more prone to hypoglycemia secondary to hyperinsulinemia in the antenatal period, and these babies may more frequently experience difficulties in sucking as a result of this condition. Therefore, pregnant women in high-risk categories (such as twin pregnancies, intrauterine growth restriction, preeclampsia, etc.) should be closely monitored. Both maternal and neonatal outcomes should be well understood and managed by the healthcare provider. Unfortunately, infants born from such pregnancies often require more intensive care in the neonatal intensive care unit (NICU), which can hinder the strengthening of the mother–infant bond. Given the awareness of these risks, psychosocial support should be provided to the mother during this process, and both the mother and the baby should be closely monitored to ensure that their reunion occurs as soon as possible [24].

2.3 Environmental risk factors

2.3.1 Separation of the mother and baby

If the baby and the mother are seperated for any reason, this can affect the breastfeeding process. These separations, caused by factors such as natural disasters, psychosocial issues, and maternal and neonatal health problems, can affect the baby's feeding schedule and access to breast milk negatively. This situation can lead to emotional, psychological, and physical consequences for both the mother and the baby. As is commonly known, establishing skin-to-skin contact within the first hour is essential for positive breastfeeding results. So, when separation occurs due to various reasons, the first priority should be to bring the mother and baby together as soon as possible for breastfeeding [4, 25].

2.3.2 Early discharge

Discharging the mother and baby before a strong bond may affect the breastfeeding process. The mother's ability and self-efficacy to breastfeed at home should be supported through strong communication with lactation consultants, neonatologists, pediatric specialists, and obstetricians. The discharge process should not be rushed;, checking and making sure of the mother gaining her confidence and knowledge in breastfeeding are really important issues. This approach will help strengthen the mother–infant bond in a healthy manner and promote the ongoing success of breastfeeding [1, 4].

2.3.3 Socioeconomic factors

The inability of the family to create an appropriate environment for breastfeeding and to cover the economic expenses related to the baby are also factors that negatively impact the breastfeeding process. It is known that in family structures

with an established routine and socioeconomic support, infant care is associated with more positive breastfeeding outcomes. Social support is crucial at this point, but it is also of great importance for families to plan according to their own circumstances. Therefore, raising awareness about family planning is important in this regard. Family planning and its importance should be communicated to society. Families who do not practice family planning can place significant pressure on the government, creating burdens in economic, social, and healthcare sectors [26].

2.4 Creating awareness for "GDM"

Being a mother with gestational diabetes mellitus (GDM) unfortunately represents a significant risk factor for breastfeeding failure. It also contributes to the risk of obesity and type 2 diabetes, thus posing a considerable public health concern. As a result, efforts to increase awareness should be sustained [17].

It is known that GDM can delay the onset of the second stage of lactogenesis (LCII). LCII is triggered by the withdrawal of progesterone, the rise in prolactin and cortisol levels, and the continuity of these processes. Studies have shown that in mothers with GDM, LCII is delayed by 15 to 28 hours during the postpartum period [17].

The delay in lactogenesis can lead to temporarily insufficient breast milk and, especially in GDM mothers, increase the risk of hypoglycemia in their babies. Difficulty in sucking can be a clinical sign of hypoglycemia, and this situation can create breastfeeding problems that worsen hypoglycemia, leading to a vicious cycle [14, 17].

Studies have observed that mothers with GDM are more likely to experience a delay in initiating breastfeeding within the first hour postpartum compared to those without GDM. In addition, it has been reported that they tend to stop breastfeeding earlier [27].

It has been mentioned in the literature that infants of mothers with GDM who are breastfed with breast milk for at least 6 months have a lower body mass index (BMI) later in life [28].

Breastfeeding and continuing breastfeeding for babies born to mothers with GDM is of great importance. Early initiation of breastfeeding for infants of mothers with GDM can reduce the risk of developing obesity or type 2 diabetes in later stages [17].

2.5 Policies to improve breastfeeding

Since 2001, the World Health Organization (WHO) has recommended exclusive breastfeeding for the first 6 months and continued breastfeeding for at least the first 2 years, with the introduction of complementary foods after 6 months.

It is a societal responsibility to ensure legal protections to prevent the use of formula milk as a substitute for breast milk and to create an environment that encourages breastfeeding. To facilitate this process, it is important to establish skin-to-skin contact between the mother and baby immediately after birth and encourage the mother to begin breastfeeding right away. All mothers should be provided with the necessary support to start breastfeeding immediately after birth, and breastfeeding support should be offered to help them manage breastfeeding challenges [29].

Institutions should ensure that mothers and babies stay together. If the mother and baby are separated during the postpartum period, mothers should be provided with the necessary support to maintain lactation (e.g., providing practical information on

breast milk expression and breastfeeding positions). Additionally, families should be provided with adequate information on nutrition, and appropriate approaches should be implemented [29].

In line with these recommendations, implementing policies that improve breastfeeding is of great importance. International breastfeeding policies, along with complementary approaches tailored to the needs, culture, and traditions of each region, can lead to an increase in breastfeeding rates. These practices include the Baby-Friendly Hospital Initiative (BFHI), which outlines how hospitals and birthing centers can support successful breastfeeding; increasing the capacity of health professionals; behavioral interventions such as public education on the benefits of breastfeeding; incorporating breastfeeding promotion into childhood obesity strategies and noncommunicable disease prevention strategies; and the implementation of the International Code of Marketing of Breast-milk Substitutes (The Code) [29].

The Baby-Friendly Hospital Initiative (BFHI), launched by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), is a strategic global program aimed at promoting, protecting, and supporting breastfeeding. Hospitals involved in BFHI should have staff training and clear policies to encourage breastfeeding from pregnancy through to postpartum hospital discharge [5].

Many studies conducted to date have shown that the Baby-Friendly Hospital Initiative (BFHI) is effective, with women who receive support in these hospitals having higher breastfeeding rates. Even in the long term, increased breastfeeding duration and higher milk production have been observed [5].

The goal of the World Health Organization (WHO) and UNICEF is to promote, protect, and support breastfeeding by implementing practices that encourage breastfeeding, known as the "Ten Steps," in hospitals. These actions aim to promote, protect, and support breastfeeding [30].

Another way to develop a breastfeeding-supportive environment is to strengthen the implementation of the Code. According to the 2020 WHO survey, the European region has the lowest proportion of countries with comprehensive legal regulations regarding the Code, with only three out of 53 countries (6%) having such regulations [29].

To increase the effectiveness of the Code, policymakers and lawmakers should understand that they must take responsibility for promoting and protecting breastfeeding and eliminate inappropriate marketing practices [29].

Countries should identify gaps in their existing laws and address these deficiencies. Additionally, by establishing effective monitoring and supervision systems, all laws should be supported with adequate budgets and human resources. As advertising for breast milk substitutes aims to reach a wider family audience on digital platforms, governments should be helped to develop appropriate policies to combat this sector with new strategies [29].

In an online survey conducted by the World Health Organization (WHO) European Child and Adolescent Health in 2020, data were collected from 53 countries that are members of the international infant formula code, using other WHO and UN sources. According to the survey results, half of the countries could not provide any data on starting breastfeeding within the first hour after birth. Among the countries with the highest rates of early initiation of breastfeeding were Belarus, Denmark, and Uzbekistan, while countries in Southeastern Europe such as Romania and Bulgaria had the lowest rates [29].

Under the "Successful Breastfeeding Strategies in Ten Steps" framework (**Table 1**), countries adhering to the code should focus on hospitals that provide education to

Basic Managment Practices
1. "A breastfeeding policy is created to ensure the protection, promotion, and support of breastfeeding practices within the organization."
1.1. "The International Code of Marketing of Breast-milk Substitutes and the relevant resolutions of the World Health Assembly are fully implemented."
1.2. "A written 'Infant Feeding Policy' is developed and regularly shared with staff and parents."
1.3. "Continuous monitoring and data management systems are established."
2. "Staff members are equipped with the knowledge, skills, and competence necessary to support mothers in breastfeeding."
Basic Clinical Practices
3. "Pregnant women and their families are informed about the importance and management of breastfeeding."
4. "Mothers are supported to initiate skin-to-skin contact with their babies as soon as possible after birth, ensuring that breastfeeding starts promptly and continues without interruption."
5. "Mothers are provided with support in managing common challenges related to initiating and sustaining breastfeeding."
6. "Unless medically necessary, no food or liquid other than breast milk is given to the newborn."
7. "Mothers are ensured to stay with their babies and remain in the same room 24 hours a day."
8. "Mothers are supported in recognizing their babies' hunger cues and responding to them appropriately."
9. "Mothers are counseled on the use and risks of bottles and pacifiers."
10. "Parents and their babies are informed about centers where they can access continuous breastfeeding support and care services before discharge."

Table 1.
"Ten Steps to Baby-Friendly" [31].

expectant mothers about breast milk and breastfeeding both before and after childbirth. These hospitals should be baby- and mother-friendly hospitals that support mothers in breastfeeding during the postpartum period and offer them up-to-date information on breastfeeding with the help of trained healthcare professionals. The target audience for baby-friendly hospitals includes new mothers, hospitals, family medicine clinics, maternal and child health centers, and health personnel working in family planning centers [31].

3. Conclusions

This section discusses the challenges encountered during breastfeeding and strategies to cope with them, emphasizing the importance of increasing awareness about breastfeeding during the prepartum, partum, and postpartum period. The breastfeeding process is not only about the mother or the baby; it is a multifactorial experience shaped by the interaction of various risk factors. In this context, greater focus should be placed on strategies aimed at enhancing the self-efficacy of mothers in high-risk pregnancy groups also. The miraculous process of breastfeeding should be ensured to occur as successfully as possible, particularly for the well-being of both the mother and the baby. Therefore, it is crucial for governments to continuously develop breastfeeding policies and implement regulations to enable more women to benefit from this process.

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Chapter 8

Perspective Chapter: Breastfeeding in Latin America – Causes of Abandonment and Its Importance for Public Health

Elena Sandoval-Pinto and Rosa Cremades

Abstract

These topics will be addressed from training and medical care, public policies, business policies, sociocultural factors and biological aspects that can influence the context of lactating women in Latin America, thus triggering the components and processes that lead to desertion or the success of breastfeeding that can be determinant indicators in breastfeeding statistics due to the effect of deficient practices. The focus of this chapter will be on Latin American women since each region of the planet presents its peculiarities in an issue as complex as breastfeeding.

Keywords: breastfeeding, abandonment, breastfeeding problems, Latin America, breastfeeding success

1. Introduction

The World Health Organization (WHO) and the Pan American Health Organization (PAHO) recognize exclusive breastfeeding (EBF) as the most optimal form of nutrition up to 6 months of age and recommend continuing breastfeeding along with the introduction of adequate and safe foods up to 2 years of age or older [1].

Currently, the Latin American and Caribbean Region (LAC), according to the United Nations, is made up of 33 countries. These present peculiarities in breastfeeding issues and, specifically, in reasons for abandoning breastfeeding, which are summarized in **Table 1**.

LAC is one of the regions in the world with the highest prevalence of EBF, a fact that is typical of low- and middle-income countries [2]. It is estimated that around 55% of babies in this region of the planet have early initiation of breastfeeding (EIBF), that is, they are breastfed during the first hour of life, 43% receive EBF, 65% of countries have less than 14 weeks (3.5 months) of maternity leave and about 54% of countries have legal measures to partially or fully implement the International Code of Marketing of Breast milk Substitutes, adopted by the World Health Assembly of the World Health Organization in 1981 and as such, seeks to protect mothers and

Factors associated with abandonment	Facilitating factors
Lower educational level or university degree	Training/educational level
Low economic income	Knowledge of rights in relation to breastfeeding
Extreme ages of life (< 20 and > 35 years), especially adolescents	Socioeconomic level
	Medical insurance
Coexistence with people other than the couple	Not working outside the home
Lack of support in breastfeeding or baby care	Maternity leave
Doubts or low intention to breastfeed	Work with flexible hours
No longer wanting to breastfeed	Short-time work
Low level of knowledge in breastfeeding	Support from the company and the work environment
Inadequate source of information	Work spaces adapted to milk extraction and storage
Lack of knowledge of the benefits of breastfeeding	EIBF
Upper-class working mothers	Baby age < 1 month
Employment	Good suction and grip
Return to work or studies	Residing in the jungle
Not EIBF	Indigenous native language
Cesarean section delivery	
Mother–child separation	
Using a bottle and pacifier	
Dairy formulas, other non-nutritive foods and liquids	
Medical supplementation recommendations	
Family supplementation recommendations	
Incorporation into mixed feeding	
Previous early weaning history	
Lack of previous experience/only child	
Incorrect posture/technique	
Child rejection	
Stress	
Lack of milk production	
Low perception of production	
Dissatisfied baby perception	
No weight gain in the baby	
Low birth weight	
Higher body mass index (BMI)	
Gestational age between 32 and 36 weeks	
Older age of the baby	
Neonate hospitalization	
Pain/discomfort in breasts and nipples	
Fear of losing the shape of the breasts	

Table 1.
Summary of the factors associated with breastfeeding cessation and facilitating factors in the Region of the Americas and the Caribbean.

babies from inappropriate promotion and marketing practices of breast milk substitutes such as infant milk formulas, teats, bottles, follow-up milk and related products [1]. However, breastfeeding levels remain suboptimal.

In 2012, the same World Health Assembly approved the global nutrition goal for 2025, setting the goal of achieving a rate of at least 50% of babies with EBF in the first 6 months of age, a goal that is far from being achieved. The World Health Organization later established the target figure of 70% by 2030 [1, 2].

Despite the multiple programs that exist to promote breastfeeding, there is still a high rate of breastfeeding abandonment in Latin America and the world, which is why it is essential to identify the main causes of abandonment in this region.

2. Relationship between breastfeeding and public health in Latin America

The practice of breastfeeding offers benefits for the mother and the infant in the short and long term, at a nutritional, physical and mental health level. Furthermore, its promotion represents a low-cost intervention with very beneficial results for public health.

From the mother's point of view, on a physical level, breastfeeding provides stronger cardiac vagal tone modulation, reduced blood pressure and reduced heart rate reactivity, some chronic diseases such as obesity, hyperlipidemia, hypertension, cardiovascular disease, type 2 diabetes are reduced (32% less risk), including some types of cancer (26% less breast cancer and 37% less ovarian cancer). On a psychological level, it reduces negative mood, anxiety and stress, with a reduced cortisol response and has a positive effect on emotional well-being and maternal care, quality of sleep; this in relation to the role of oxytocin during breastfeeding and the consequent reduction of cortisol levels [1, 3, 4].

In the baby, EIBF reduces neonatal death by 22% [5], and breastfeeding reduces the risk of sudden death by 60%, this percentage being higher in babies with EBF [1]. EBF during the first 6 months protects against respiratory, gastrointestinal, ear and urinary infections and diseases. Prolonged breastfeeding protects in childhood against diseases such as overweight and obesity by 13% and, consequently, also against diseases derived from these conditions, as well as reducing the risk of childhood leukemia by 19% [1]. Breastfeeding also offers benefits in cognitive development (greater language skills, memory retention and intelligence) and motor development, in a child's brain, and in socio-emotional development [3, 4]. Thus, an increase in cognitive level is associated with a higher level of schooling and higher income in these adults who were breastfed. In addition to providing perfect nutrition, the different components of breast milk are estimated to have an effect on epigenetic programming at critical moments of gene expression throughout life [1].

Additionally, breastfeeding provides common benefits to the mother-baby binomial, facilitating bonding and secure attachment thanks to greater maternal sensitivity and greater moments of interaction [1, 4].

All of these advantages are especially important in the context of Latin American countries, which face major public health challenges such as obesity and type 2 diabetes rates that are among the highest in the world and fastest growing. This is due to educational deficiencies at the population level and among health professionals, impoverished health systems and deficient public policies regarding disease prevention and control strategies [6].

Thus, it is estimated that breastfeeding prevents more than one million deaths a year worldwide and is an ideal and safe nutritional practice, with zero economic cost and zero environmental impact and with a comprehensive health benefit [7].

3. Key factors in the dropout and success of breastfeeding in Latin America

There are socioeconomic, cultural and individual determinants that can affect breastfeeding practices and decisions: age, nutritional and health status of the mother, type of birth, number of prenatal care visits, socioeconomic level, maternal work, level of maternal education, maternal breastfeeding education and maternal breastfeeding self-efficacy and social environment, among others, which affect the

initiation and duration of breastfeeding; these being key factors for the success or abandonment of this practice [2, 8].

In LAC, a pattern similar to that of other countries is observed, in which the frequency of EBF decreases with increasing age of the baby, a fact that reveals its short duration. Conversely, the mother's socioeconomic level and her level of training are established as protective factors for breastfeeding [2].

In Mexico, according to the National Health and Nutrition Survey (ENSANUT), the prevalence of EBF up to 6 months in 2018 was 28.8% [9]. In a study carried out in the northeast of Mexico among upper-class women, it was observed that the prevalence of EBF at 6 months was 28%. Upper-class working mothers are less likely to continue breastfeeding. There was a risk association with employment, bottle use in the first 6 months and a low level of knowledge [10]. In another study carried out in a community in Veracruz, Mexico, regarding termination factors, the women surveyed mentioned that the lack of breast milk production (16.1%) and incorporation into work (9.7%) are the main factors for termination of breastfeeding [11]. In a study carried out in a semi-rural community in the state of Tabasco, Mexico, with 143 mothers with children aged 4 to 6 months, they observed that at the end of the first month postpartum, 51.7% of the participants had abandoned EBF, introduced milk formulas (35%), other foods (9.1%), non-nutritive liquids (7.7%) or had stopped breastfeeding completely [12]. In the following months, the practice of EBF decreased drastically and mixed feeding increased significantly. Among the factors that affected the continuity of EBF was the fact that the babies were given other liquids during their hospital stay; experienced breast/nipple pain or discomfort or used a pacifier after hospitalization; they had larger bodies (i.e., higher BMI); and they believed that powdered milk or some other food should be given to the baby when the baby is not satisfied [12].

In Santiago de Chile Niño R *et al.* identified in 414 surveys conducted with lactating women (256 public sector and 158 private sector) that weaning is often related to maternal perceptions rather than objective data. Sociodemographic variables influence successful breastfeeding. Greater education in health checks and lactation clinics would improve this situation [13].

In a study carried out in Bolivia on one hundred mothers and their children, they found that the causes of abandoning breastfeeding were hospitalization of neonates (79%) and low birth weight (52%). Health personnel suggested substitutes due to hypogalactia in 18% of mothers. Incorrect posture of the mother: 66.1 and 61%, without previous experiences. Success factors for relactation were: chronological age less than 1 month (48%); the baby sucked when put to the breast (89%); good grip (71%). During the non-breastfeeding period, 72% received mixed milk, 82% did not breastfeed between 8 and 30 days, 98% of mothers were willing to relactate, and 91% demonstrated good support from their families and health personnel [14].

According to JP Lizarazo 2023, in 124 Colombian patients, the main cause of abandonment was the perception of low breast milk production in 43.5% of the mothers surveyed. The gestational age of the newborns was 32 to 36 weeks in 61.3% of the patients [15].

In a study carried out in Peru, 11,296 mothers with children 6 months or older were included. 26.2% of mothers discontinued EBF. The associated factors with breastfeeding abandonment were: mothers with a higher educational level and being an only child. Protective factors were found to be: residing in the jungle, native indigenous language, the receiving of training in breastfeeding, and having health insurance [16].

In Argentina, a study carried out by Mangialavori GL *et al.* in 2022 identified that the prevalence of EBF in children under 6 months was 53.5% and at 4 and 6 months, 51.5% and 41.7%, respectively. The prevalence of breastfeeding in children aged 12–15 months was 77.8%. In addition to the above, they observed variables that were independently associated with a lower frequency of EBF and breastfeeding, including: older age, lower level of maternal education, cesarean delivery, low birth weight, initial breastfeeding after of the first hour and separation from the mother–child dyad ≥4 hours a day [17].

In Guatemala, a study was carried out using a survey to identify the factors that affect EIBF and EBF among mothers in the urban periphery of Guatemala City. They found that the most important determining factor of EBF was the fact that the mother works outside the home, and women who did not work outside the home were 3.2 times more likely to exclusively breastfeed than women who worked outside the home. In addition to the above, they also identified that bottle use is associated with less EBF [18].

Work is a factor that is included within the context of breastfeeding women. In a study in Brazil in 2023 on the factors associated with abandonment in the first month after starting work, it was observed that the frequency of EBF was lower in employed mothers (26%), compared to those who did not work outside the home (43.9%) or were on maternity leave (53.4%). Although the intention to breastfeed after returning to work was almost complete, 13% abandoned the practice and the majority did not breastfeed or express milk during the work day, although they reported a friendly environment. The factors that showed statistical significance with abandonment were having a university degree, having no intention or having doubts, using a pacifier, living with people other than one's partner, not having support in breastfeeding or caring for the baby, and older baby's age. It is notable that most of the abandonment factors in these conditions are not directly related to the woman's work. Among the work factors that favor breastfeeding, the following stood out: flexible hours, reduced working hours, daycare, support from the company and the work environment, availability of adequate spaces for the extraction and storage of breast milk, educational level and knowledge of rights in relation to breastfeeding. The longer duration of EBF was also a protective factor (1% less early weaning for each day of EBF) [19].

In Venezuela, a study was carried out on 105 mothers to whom a survey was applied, and they were able to observe that abandoning this practice before 4 months was more frequent in the extreme age groups of life, that is, in those under 20 and those over 35 years of age. The main causes of dropout were due to returning to school and/or work and lack of knowledge about the subject [20].

In a study carried out by Fernández Gonzáles *et al*. on 27 mothers of children born in Cuba on risk factors related to abandoning EBF, they identified that maternal age, history of previous early weaning, incorporation into student life, feeling of lack of milk production, mastalgia and cracks in the nipples were the main factors related to the abandonment of breastfeeding [21]. In another study carried out in Puerto Padre Cuba with 141 participants, they found abandonment of breastfeeding in the majority of children between three and 4 months of age. In relation to the factors associated with the mother for abandoning breastfeeding, it was found that the mothers' knowledge related to breastfeeding is deficient. The number of serious maternal diseases is not significant, and mastitis is predominantly in the age group of adolescents [22].

In Ecuador, a study carried out by Maza, found that there are multiple reasons that lead to abandonment of EBF, especially conditions related to the mother,

among which are sociodemographic conditions, poor level of knowledge about the benefits of breastfeeding, academic training, family support, stress and biological factors, among which are low milk production, pain, cracks, and inflammation triggered by inadequate posture when breastfeeding [23]. In another study carried out in Ecuador on 73 nursing mothers, it was possible to identify that the main cause of abandonment of EBF was detected at the beginning of the studies, since the participants were mainly between 14 and 16 years of age. Among other causes detected, the following stand out: the low level of knowledge on the subject, low economic income, not having an appropriate source of information, and poor breastfeeding technique [24].

In Paraguay, a study was carried out on 60 maternal patients at the Fernando de la Mora Maternal and Child Hospital, where the main causes of breastfeeding abandonment were identified, among which the following stood out: insufficient milk, work, rejection by the child and no longer wanting to breastfeed [25]. In another study carried out in Greater Asunción, Paraguay in 60 children, the reasons for stopping breastfeeding mentioned by mothers were related to insufficient milk production to satisfy the child and generate weight gain, recommendations from health personnel or a family member, perception of low production, the mother's work and rejection of the baby [26].

In the Dominican Republic, a study was carried out on 220 mothers from Santo Domingo to identify the community causes of abandonment of breastfeeding, among which were the fear of losing the shape or shape of the breasts, not wanting to breastfeed, the child not wanting breast and insufficient milk [27].

4. Training and medical care in breastfeeding in Latin American countries

Training in lactation counseling is acquired through national or international institutions or associations that try to provide certifications that endorse the specific knowledge of anyone who wishes to deepen this knowledge, especially aimed at health professionals. Thus, the "International Board Certified Lactation Consultant" (IBCLC) certification granted by the IBLCE®, or the International Board of Lactation Consultant Examiners®, is one of the most recognized and prestigious in this field at an international level, whose function is provide expert breastfeeding and lactation care, provide education in pre- and postnatal breastfeeding to reduce the risks of not breastfeeding and attend to particular needs regarding breastfeeding problems. For this certification, you must have health training or complete it according to IBLCE® standards, and you need to reaccredit every 5 years. Other institutions with a presence in Latin America are CAPPA Latin America, which grants the CLE® certificate, among others.

The last public registry of IBCLCs, from March 2022, reports the existence of 34,069 IBCLCs in 129 countries in the world, and in the online update of February 16, 2024, the figure rises to 37,262 of IBCLCs worldwide. Among the main LAC countries, 262 stand out in Brazil, 194 in Mexico, 104 in Chile, 73 in Peru, 71 in Argentina, 65 in Colombia, 31 in Ecuador, 20 in Costa Rica, 11 in Guatemala, 9 in the Dominican Republic, 7 in Uruguay, 6 in Paraguay, 6 in Panama, 4 Trinidad and Tobago, 3 Bolivia, 2 Haiti, 1 Honduras, 1 El Salvador, and 1 Venezuela. LAC countries without people who have this certification are Nicaragua, Belize, Cuba, Jamaica, Bahamas, Barbados, Saint Lucia, Grenada, Saint Vincent and the Grenadines, Antigua and Barbuda, Dominica, Saint Kitts and Nevis, Guyana, and Suriname [28, 29].

5. Public and business policies on breastfeeding issues in Latin America

Returning to work is one of the most important barriers to breastfeeding. Family-friendly policies are essential to ensure that breastfeeding and maternal work are not mutually exclusive [30].

In a study conducted by Nandi *et al.* on national demographic and health surveys (ENDS) of 20 countries between 2000 and 2008, identified that each additional month of paid maternity leave was associated with 7.9 fewer infant deaths per 1000 live births [31].

According to the reports of the Economic Commission for Latin America and the Caribbean (CEPAL, acronym in Spanish) and the United Nations Fund for Children (UNICEF) on maternal and child care in the Latin American region:

> *"Wage workers in Latin America have on average three months of maternity leave, a period less than the minimum limit of 14 weeks, as established in the Convention on Maternity Protection of the International Labor Organization (OIT, acronym in Spanish)" [32].*

Regarding maternity leave, CEPAL reports that only Chile, Cuba, Venezuela and Brazil grant leaves of more than 3 months, with Chile, Cuba and Venezuela, for 18 weeks, and Brazil, for 6 months, to public sector workers [32].

Regarding paternity leave, the average number of days authorized in the said region is 2–5 days. Only in Ecuador, Venezuela and Cuba are the terms longer (10 days, 14 days, and 6 months, respectively) [32].

Furthermore, according to PAHO, workplace policies that support breastfeeding increase employee fidelity and loyalty to the workplace, productivity, performance and team spirit [1].

Among the resources to support breastfeeding as a fundamental element within the PAHO Action Plan for the Prevention of Obesity in Children and Adolescents, PAHO generated the "Baby-Friendly Hospital Initiative", which offers technical support in different countries and assists in the accreditation processes [1].

Another document that supports breastfeeding is the LAC Code Against Cancer, which was created based on the 4th edition of the same European code and under the strategies and guidelines set out by it in the World Code Against Cancer Framework. Thus, LAC experts, in collaboration with the World Health Organization and PAHO, expressed the following in point 7 of this code:

> *"Breastfeed your baby - the more months the better - to help prevent breast cancer and excess weight in your baby" [33].*

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Clinical Guidance in Breastfeeding - Physiology, Success, and Challenges is a clear, evidence-based guide for those working with mothers and infants. It distils current research on milk production, psychosocial influences, and clinical management into practical tools for daily care. Inside are step-by-step algorithms for latch and positioning, updated protocols for pre-term or medically fragile babies, and ready-to-use strategies for low supply. Multidisciplinary in scope, the book pairs quick-reference tables with real-world cases to turn science into confident action. Clinicians, lactation consultants, nurses, and programme planners will find everything they need to protect, promote, and support breastfeeding in any setting.

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