

Breastfeeding and maternal–infant health: benefits, barriers, commercial influences and strategies for sustainable support

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Abstract:

Breastfeeding is a fundamental component of maternal and infant health, providing nutritional, immunological, developmental, psychological, and long-term health benefits for both mother and child. Despite strong international recommendations supporting exclusive breastfeeding during the first six months of life and continued breastfeeding with complementary feeding thereafter, optimal breastfeeding practices remain inadequate across many populations. This review examines the multifaceted contribution of breastfeeding to infant survival, immune protection, neurodevelopment, maternal recovery, chronic disease prevention, and mother–infant bonding. It further explores the social, economic, cultural, and structural factors that influence breastfeeding initiation and continuation. Particular attention is given to the growing commercialization of infant feeding, including marketing of breast-milk substitutes, digital promotion, and industry influence on parental decision-making. Workplace constraints, inadequate maternity protection, limited lactation support, sociocultural stigma, gender-related responsibilities, and socioeconomic inequalities are also examined as important determinants of breastfeeding outcomes. The review additionally considers the environmental implications of infant feeding, highlighting the resource use, packaging, waste, and carbon footprint associated with formula production and distribution. Evidence from global health initiatives indicates that effective breastfeeding promotion requires coordinated action involving healthcare systems, governments, workplaces, communities, and regulatory bodies. Strengthening lactation counseling, implementing breastfeeding-friendly workplace policies, protecting families from inappropriate marketing, and promoting culturally sensitive community support are essential to creating enabling environments for breastfeeding. Overall, breastfeeding should be recognized not merely as an individual feeding decision but as a major public health, social equity, and sustainability priority requiring supportive policies and multisectoral commitment.

Keywords:

Breastfeeding; Maternal Health; Infant Health; Lactation Support; Breast-Milk Substitutes; Maternity Protection; Commercialization; Health Inequities; Public Health; Sustainability.

1. Introduction:

Breastfeeding is widely recognized as one of the most effective and cost-efficient public health interventions for improving infant survival and enhancing population health outcomes globally (Victora et al., 2016). Extensive epidemiological evidence demonstrates that breastfeeding significantly reduces neonatal and infant mortality by protecting against infectious diseases, malnutrition, and growth failure (WHO, 2023). Breastfed infants experience optimal physical growth trajectories and improved neurodevelopmental outcomes compared to non-breastfed infants, particularly during the critical first 1,000 days of life (Horta et al., 2018). In addition to infant benefits, breastfeeding contributes substantially to maternal health by reducing the risk of postpartum complications and chronic diseases later in life (Stuebe, 2020). The World Health Organization recommends

exclusive breastfeeding for the first six months of life, followed by continued breastfeeding alongside nutritionally adequate complementary foods for at least two years or beyond (WHO, 2023). This recommendation is grounded in robust scientific evidence indicating that exclusive breastfeeding during early infancy provides complete nutrition while strengthening immune defenses against common childhood illnesses (UNICEF, 2023). Despite global endorsement of these guidelines, adherence remains inconsistent across regions and socioeconomic groups, highlighting gaps between policy recommendations and real-world practices (Neves et al., 2021). Global breastfeeding rates remain suboptimal, particularly in urbanized and market-driven societies where sociostructural barriers limit sustained breastfeeding practices (OECD, 2022). Rapid urbanization, changing family structures, and increased female participation in the labor force have contributed to declining breastfeeding duration, especially in high-income and middle-income countries (Rollins et al., 2016). In these contexts, breastfeeding is often framed as incompatible with modern lifestyles, reinforcing perceptions that formula feeding is a more convenient or socially acceptable alternative (Smith et al., 2018). Commercial pressures play a significant role in shaping infant feeding decisions, particularly through the aggressive marketing of breast-milk substitutes (WHO, 2022). Formula companies employ sophisticated advertising strategies that exploit parental concerns about infant nutrition, growth, and sleep, often positioning formula as equivalent or superior to breast milk (Pereira et al., 2024). Such marketing practices undermine maternal confidence in breastfeeding and directly contradict international public health guidance (Rollins et al., 2016). Structural barriers within health systems further exacerbate challenges to breastfeeding, particularly in settings where maternity protection policies are weak or poorly enforced (Heymann et al., 2017). Limited access to paid maternity leave, lack of workplace lactation facilities, and inflexible work schedules reduce women's ability to initiate and sustain breastfeeding (WHO, 2023). These barriers disproportionately affect women in low-wage and informal employment sectors, reinforcing social inequities in breastfeeding outcomes (Neves et al., 2021).

In recent decades, the tension between biologically rooted nurturing practices and market-oriented health systems has intensified as healthcare increasingly operates within profit-driven frameworks (Victora et al., 2023). Breastfeeding, which is inherently non-commercial and relational, often receives less institutional support compared to marketable medical or nutritional interventions (Smith et al., 2018). This imbalance reflects broader societal trends in which caregiving labor is undervalued and inadequately protected within economic systems (OECD, 2022). While breastfeeding offers profound short- and long-term benefits for both infants and mothers, it increasingly competes with a rapidly expanding global infant formula industry (Pereira et al., 2024). The global formula market, valued at over USD 55 billion, continues to grow through aggressive expansion into emerging economies and digital marketing platforms (Pereira et al., 2024). This commercial growth often occurs in parallel with weak regulatory enforcement of the International Code of Marketing of Breast-milk Substitutes, allowing unethical promotional practices to persist (WHO, 2022). From a biological perspective, breastfeeding provides unparalleled protection against infectious diseases by transferring maternal antibodies, immune cells, and bioactive compounds to the infant (Ballard & Morrow, 2017). Breast milk also plays a critical role in shaping the infant gut microbiome, which influences immune maturation and metabolic health across the life course (Lyons et al., 2020). These biological mechanisms contribute to lower rates of respiratory infections, diarrheal diseases, and sudden infant death syndrome among breastfed infants (Victora et al., 2016). The benefits of breastfeeding extend beyond infancy, with long-term associations observed in cognitive development, educational attainment, and reduced risk of obesity and non-communicable diseases (Horta et al., 2018). Breastfeeding has been linked to higher intelligence scores and improved academic performance, particularly in low- and middle-income settings where nutritional risks are higher (Victora et al., 2016). These findings underscore breastfeeding as an investment in human capital development and societal well-being (UNICEF, 2023). Maternal health outcomes are similarly influenced by breastfeeding practices, with evidence demonstrating reduced risks of breast cancer, ovarian cancer, type 2 diabetes, and cardiovascular disease among women who breastfeed (Stuebe, 2020). The protective effects of breastfeeding on maternal health exhibit a dose-response relationship, with longer durations associated with greater risk reduction (Chowdhury et al., 2015). These findings position breastfeeding as a preventive health strategy with implications across the female life course (ACOG, 2021). Beyond physical health, breastfeeding fosters emotional bonding and psychological well-being through neurohormonal pathways involving oxytocin and prolactin (Uvnäs-Moberg et al., 2020). These hormonal responses promote maternal-infant attachment, stress reduction, and emotional regulation, contributing to positive mental health outcomes for mothers (Dias & Figueiredo, 2015). However, lack of support and societal pressure to breastfeed can also contribute to maternal distress, emphasizing the need for compassionate and individualized breastfeeding support (Smith et al., 2018). To contextualize the scope of breastfeeding benefits early in this discussion, Figure 1 illustrates the multi-system protective effects of breastfeeding on infant health, including immune, metabolic, and neurodevelopmental outcomes (Victora et al., 2016). The figure highlights how breastfeeding operates

simultaneously across biological systems, reinforcing its role as a comprehensive health intervention rather than a singular nutritional choice (Ballard & Morrow, 2017). Visual representations such as this are essential for communicating the complexity and magnitude of breastfeeding benefits within both clinical and policy contexts (WHO, 2023).

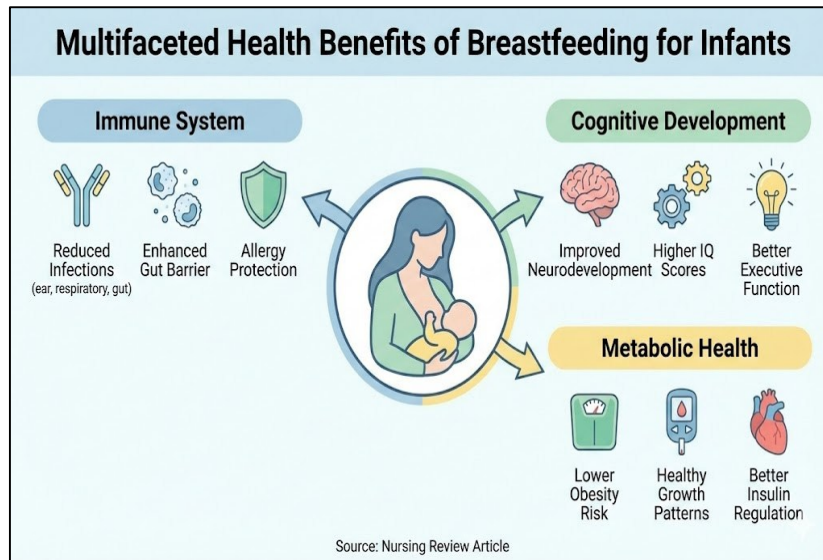


Figure. 1: Multifaceted health benefits of breastfeeding for infants across immune, cognitive, and metabolic systems

2. Global Trends and Patterns in Breastfeeding:

Breastfeeding prevalence varies substantially across global regions and income levels, reflecting deep-rooted socioeconomic, cultural, and policy-related differences that shape infant feeding practices worldwide (UNICEF, 2023). In many low-income countries, breastfeeding initiation rates are relatively high due to cultural norms, limited access to breast-milk substitutes, and strong intergenerational knowledge transmission supporting breastfeeding practices (Victora et al., 2016). However, despite high initiation rates in these settings, exclusive breastfeeding often declines rapidly within the first few months postpartum as a result of maternal undernutrition, early introduction of complementary foods, and insufficient postnatal support systems (UNICEF, 2023). In low- and middle-income countries, early cessation of exclusive breastfeeding is frequently influenced by misconceptions regarding breast milk sufficiency and infant growth needs (Neves et al., 2021). Health system constraints, including limited access to skilled lactation counseling and inconsistent messaging from healthcare providers, further contribute to premature supplementation with water, animal milk, or formula (WHO, 2022). Additionally, aggressive marketing of breast-milk substitutes in these regions undermines traditional breastfeeding practices and weakens maternal confidence in exclusive breastfeeding (Rollins et al., 2016). In contrast, high-income countries often report relatively high breastfeeding initiation rates due to strong prenatal education and hospital-based breastfeeding promotion initiatives (OECD, 2022). Despite these promising initiation figures, breastfeeding duration and exclusivity remain consistently low in many high-income settings, particularly beyond the first three months postpartum (OECD, 2022). Work-related constraints, including early return to employment and inflexible working conditions, represent major barriers to sustained breastfeeding in these contexts (Heymann et al., 2017). Social norms in high-income societies further influence breastfeeding continuation, as formula feeding is often normalized and portrayed as a convenient alternative compatible with modern lifestyles (Smith et al., 2018). Public discomfort with breastfeeding, particularly in workplaces and public spaces, contributes to maternal stress and discourages prolonged breastfeeding (OECD, 2022). These sociocultural pressures interact with structural barriers to create environments that are unsupportive of sustained breastfeeding practices (Neves et al., 2021). Recent global surveillance data indicate that progress in breastfeeding promotion has stagnated over the past decade, despite the establishment of ambitious international nutrition targets (WHO & UNICEF, 2022). Global estimates suggest that fewer than half of infants under six months of age are exclusively breastfed, falling short of the World Health Assembly target of at least 50% exclusive breastfeeding by 2025 (WHO, 2023). This stagnation reflects insufficient policy implementation rather than a lack of scientific evidence supporting breastfeeding benefits (Victora et al., 2023). Figure 2 presents a comparative overview of exclusive breastfeeding rates across world regions, highlighting pronounced disparities between low-income, middle-income, and high-income countries (UNICEF, 2023). The figure illustrates how exclusive breastfeeding prevalence is highest in certain

low-income regions but declines sharply as countries undergo economic development and market integration (Neves et al., 2021). These patterns underscore the inverse relationship between commercialization and sustained breastfeeding practices observed in many transitioning economies (Rollins et al., 2016).

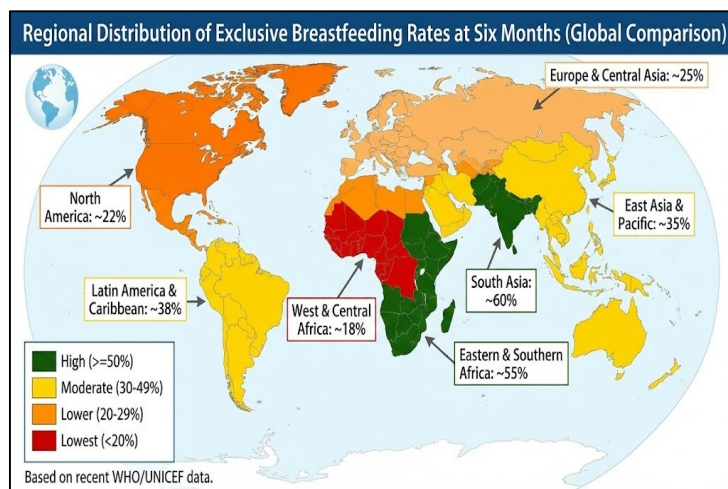


Figure 2. Regional distribution of exclusive breastfeeding rates at six months (global comparison)

Socioeconomic development often brings increased access to breast-milk substitutes, expanded marketing exposure, and changing perceptions of infant feeding norms (Pereira et al., 2024). As household incomes rise, formula feeding may become perceived as a symbol of modernity, social status, or maternal success, particularly in urban settings (Smith et al., 2018). This perception is frequently reinforced by targeted advertising strategies that associate formula feeding with convenience, intelligence, and health outcomes (WHO, 2022). Urbanization has emerged as a critical determinant of declining breastfeeding duration worldwide, particularly in rapidly developing regions (Neves et al., 2021). Urban living often entails reduced family support, increased maternal workload, and limited opportunities for on-demand breastfeeding, all of which negatively affect breastfeeding continuation (UNICEF, 2023). Informal settlements and urban poverty further exacerbate these challenges by limiting access to breastfeeding-friendly healthcare and social services (Victora et al., 2016). Increased female labor force participation, while a positive indicator of gender equity, has paradoxically contributed to reduced breastfeeding duration in the absence of adequate maternity protection policies (Heymann et al., 2017). Women employed in informal or precarious work arrangements are particularly vulnerable to early breastfeeding cessation due to lack of paid leave and workplace accommodations (WHO, 2023). These conditions highlight the critical role of labor policies in shaping breastfeeding outcomes at the population level (OECD, 2022). The normalization of formula feeding across diverse socioeconomic contexts has further contributed to declining breastfeeding duration worldwide (Rollins et al., 2016). Formula feeding is frequently framed as a medically endorsed and nutritionally complete alternative, obscuring the unique immunological and developmental benefits of breast milk (Ballard & Morrow, 2017). This normalization diminishes the perceived urgency of breastfeeding support within both health systems and families (Smith et al., 2018). Importantly, these trends reflect not individual maternal choice alone, but broader structural, economic, and political pressures that shape infant feeding decisions (Victora et al., 2023). Women's infant feeding practices are deeply embedded within systems that prioritize productivity, market growth, and convenience over caregiving and reproductive labor (OECD, 2022). Framing breastfeeding outcomes solely as a matter of personal responsibility obscures the systemic barriers that constrain maternal agency (Neves et al., 2021). Health inequities further compound regional disparities in breastfeeding prevalence, with marginalized populations facing greater exposure to formula marketing and fewer breastfeeding support resources (UNICEF, 2023). Indigenous women, migrants, and low-income urban populations often experience intersecting vulnerabilities that reduce breastfeeding initiation and duration (Smith et al., 2018). Addressing these inequities requires culturally sensitive interventions and community-based breastfeeding support models (WHO, 2023).

3. Biological Foundations of Breastfeeding and Infant Health:

Human breast milk is a dynamic, living, and bioactive fluid uniquely tailored to meet the evolving nutritional, immunological, and developmental needs of the human infant, functioning not merely as food but as a complex biological system that actively communicates with and shapes infant physiology (Ballard & Morrow, 2017). It contains a diverse array of immunoglobulins, particularly secretory IgA, along with lactoferrin, lysozyme,

cytokines, growth factors, hormones, enzymes, human milk oligosaccharides (HMOs), and beneficial microbes that together create a protective and regulatory environment impossible to fully replicate in artificial substitutes (Ballard & Morrow, 2017; Lyons et al., 2020). These components work synergistically to guide immune maturation, train immune tolerance, and promote the establishment of a healthy gut microbiome during critical early-life windows of development (Lyons et al., 2020). HMOs, for example, selectively nourish beneficial gut bacteria such as *Bifidobacterium* species while simultaneously acting as decoy receptors that prevent pathogen adhesion to the intestinal mucosa, thereby reducing infection risk and inflammation (Lyons et al., 2020). Breast milk-derived immune cells and bioactive signaling molecules further modulate inflammatory responses and enhance epithelial barrier integrity, contributing to long-term gut and immune resilience (Ballard & Morrow, 2017). As a result of these integrated biological processes, breastfed infants consistently demonstrate lower incidence and severity of respiratory tract infections, gastrointestinal illnesses such as diarrhea, and middle ear infections when compared with formula-fed infants across diverse global settings (Victora et al., 2016). Large epidemiological studies also show a significant protective association between breastfeeding and reduced risk of sudden infant death syndrome, likely mediated through improved autonomic regulation, immune protection, and sleep-wake physiology (Sankar et al., 2015). Beyond protection against acute illness, breastfeeding has been linked to long-term health benefits, including reduced risk of obesity, type 2 diabetes, and allergic disease, underscoring its role in metabolic and immunological programming (Victora et al., 2016). Neurodevelopmental outcomes are also positively influenced by breastfeeding, as breast milk supplies long-chain polyunsaturated fatty acids, hormones, and growth factors essential for brain structure and synaptic development (Horta et al., 2018). Multiple longitudinal studies and meta-analyses demonstrate that individuals who were breastfed score higher on standardized cognitive assessments and intelligence quotient measures later in childhood and adulthood, even after adjusting for socioeconomic and maternal factors (Horta et al., 2018). These cognitive advantages are believed to arise from both the direct nutritional composition of breast milk and the indirect effects of improved health and reduced early-life morbidity (Horta et al., 2018). Importantly, breast milk composition is not static but adapts over time in response to infant age, health status, and even circadian rhythms, further highlighting its biological specificity and responsiveness (Ballard & Morrow, 2017). The interaction between breast milk bioactives and infant physiological systems is therefore best understood as a dynamic feedback loop in which nutrition, immunity, and development are continuously coordinated (Lyons et al., 2020). These mechanisms are visually summarized in figure 3, which illustrates how breast milk components interact with the infant gut, immune system, and neurodevelopmental pathways to produce both immediate and lifelong health benefits (Victora et al., 2016).

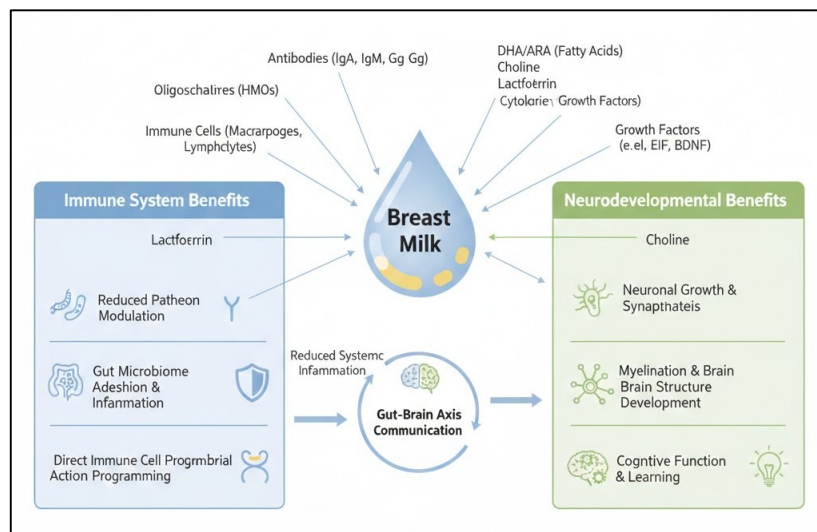


Figure 3. Mechanisms linking breast milk components to infant immune and neurodevelopmental outcomes

4. Maternal Health Benefits of Breastfeeding:

Breastfeeding plays a crucial role in promoting maternal health, offering a spectrum of immediate physiological benefits and long-term disease protection that extend well beyond the postpartum period, thereby positioning lactation as a significant life-course health intervention rather than solely an infant feeding practice (ACOG, 2021). In the immediate postpartum phase, the act of breastfeeding stimulates the release of oxytocin, a hormone that promotes uterine involution, accelerates the return of the uterus to its pre-pregnancy size, and significantly reduces the risk of postpartum hemorrhage, which remains a leading cause of maternal morbidity

and mortality worldwide (ACOG, 2021). Lactation also contributes to improved maternal recovery by facilitating postpartum weight loss through increased energy expenditure and by supporting metabolic adaptations that enhance glucose and lipid regulation during the early postpartum period (Stuebe, 2020). Over the long term, substantial epidemiological evidence demonstrates that women who breastfeed experience a lower risk of hormone-related malignancies, particularly breast and ovarian cancer, with protective effects increasing as cumulative breastfeeding duration rises (Chowdhury et al., 2015). This cancer risk reduction is believed to result from decreased lifetime exposure to estrogen, enhanced differentiation of breast tissue, and the shedding of potentially damaged mammary epithelial cells during lactation and involution (Chowdhury et al., 2015). In addition to cancer prevention, breastfeeding is associated with a significantly reduced risk of type 2 diabetes, especially among women with a history of gestational diabetes, likely due to improved insulin sensitivity and long-term metabolic recalibration induced by lactation (Stuebe, 2020). Cardiovascular health benefits are also well documented, with breastfeeding linked to lower incidence of hypertension, hyperlipidemia, and cardiovascular disease events later in life, suggesting that lactation favorably influences vascular function and inflammatory pathways (Stuebe, 2020). Large pooled analyses and meta-analyses consistently identify a clear dose–response relationship, wherein longer duration and greater cumulative exposure to breastfeeding correspond with progressively stronger protection against chronic diseases, reinforcing the biological plausibility of these associations (Victora et al., 2016). Women who breastfeed for twelve months or longer across their reproductive lifespan demonstrate the greatest reductions in all-cause mortality and non-communicable disease risk compared with those who breastfeed for shorter durations or not at all (Victora et al., 2016). These findings highlight breastfeeding as a modifiable behavior with profound implications for women’s long-term health trajectories, particularly in the context of rising global burdens of cancer, diabetes, and cardiovascular disease (Chowdhury et al., 2015). Beyond biological mechanisms, breastfeeding may also promote maternal mental health through enhanced maternal–infant bonding and neuroendocrine regulation, including reduced stress responses and lower rates of postpartum depression, although outcomes may vary depending on social support and breastfeeding experiences (Stuebe, 2020). Importantly, these maternal health outcomes are not uniformly distributed, as structural barriers, workplace policies, and socioeconomic inequities influence breastfeeding initiation and duration, thereby shaping who ultimately benefits from its protective effects (Victora et al., 2016). Table 1 summarizes key maternal health outcomes associated with varying durations of breastfeeding, emphasizing the cumulative and graded nature of these benefits across the life course (ACOG, 2021). Collectively, the evidence underscores breastfeeding as a powerful, cost-effective public health strategy that supports women’s immediate recovery from childbirth while substantially reducing long-term disease risk, reframing lactation as a cornerstone of preventive women’s health rather than a practice confined to infancy alone (Stuebe, 2020).

Table 1: Maternal Health Outcomes Associated with Breastfeeding Duration

Health Outcome	Risk Reduction Associated with Breastfeeding
Breast cancer	4–7% reduction per year of breastfeeding
Ovarian cancer	Significant reduction with ≥ 12 months
Type 2 diabetes	30–40% reduced risk
Cardiovascular disease	Lower hypertension and stroke risk

5. Breastfeeding, Mental Health, and the Mother–Infant Bond:

Beyond its well-established physical health benefits, breastfeeding plays a significant role in shaping maternal emotional well-being and the quality of the maternal–infant relationship through complex neurohormonal and psychosocial pathways, highlighting its importance as an experience that extends into mental and emotional domains of health (Uvnäs-Moberg et al., 2020). Central to this process is the release of oxytocin during breastfeeding, a neuropeptide often referred to as the “bonding hormone,” which is secreted in response to nipple stimulation and promotes feelings of calm, trust, and emotional connection between mother and infant (Uvnäs-Moberg et al., 2020). Oxytocin simultaneously dampens activity in the hypothalamic–pituitary–

adrenal axis, leading to reduced cortisol levels and decreased physiological stress responses, thereby supporting maternal emotional regulation during the vulnerable postpartum period (Uvnäs-Moberg et al., 2020). Through these mechanisms, breastfeeding may enhance maternal sensitivity, responsiveness, and attunement to infant cues, reinforcing secure attachment and strengthening early relational bonds that are foundational for infant socioemotional development (Dias & Figueiredo, 2015). Empirical studies suggest that mothers who breastfeed often report greater confidence in their caregiving role and increased feelings of closeness with their infants, which may buffer against emotional distress during early motherhood (Dias & Figueiredo, 2015). In this context, breastfeeding has been associated with lower rates of postpartum depression, with several observational studies indicating a protective relationship between breastfeeding initiation or continuation and reduced depressive symptoms (Dias & Figueiredo, 2015). However, the relationship between breastfeeding and maternal mental health is complex and bidirectional, as depressive symptoms can also impair breastfeeding initiation and duration, making it difficult to establish clear causality (Dias & Figueiredo, 2015). Neurobiological models suggest that the repeated activation of oxytocinergic pathways during breastfeeding may enhance emotional resilience and promote positive affect, yet these benefits are not universal and depend heavily on individual experiences and contextual factors (Uvnäs-Moberg et al., 2020). Figure 4 illustrates the neurohormonal pathways activated during breastfeeding, demonstrating how oxytocin, prolactin, and dopamine interact to support stress reduction, emotional regulation, and maternal–infant bonding at the neural level (Uvnäs-Moberg et al., 2020). Importantly, when breastfeeding is experienced as painful, overwhelming, or unsupported, these same processes may be disrupted, potentially contributing to heightened stress, feelings of inadequacy, and emotional distress rather than well-being (Dias & Figueiredo, 2015). Research indicates that breastfeeding difficulties, such as latch problems, low milk supply, or infant feeding challenges, are associated with increased risk of anxiety and depressive symptoms, particularly when mothers internalize blame or feel pressure to persist despite significant hardship (Dias & Figueiredo, 2015). Furthermore, coercive or idealized public health messaging that frames breastfeeding as a moral obligation rather than a supported choice can exacerbate guilt, shame, and psychological distress among mothers who are unable or choose not to breastfeed (Dias & Figueiredo, 2015). These findings underscore the importance of recognizing maternal autonomy and mental health as integral components of breastfeeding promotion strategies, rather than positioning breastfeeding as an all-or-nothing determinant of good motherhood (Uvnäs-Moberg et al., 2020). Supportive environments that provide skilled lactation assistance, flexible feeding options, and nonjudgmental counseling are more likely to enable mothers to experience the emotional benefits of breastfeeding without compromising psychological well-being (Dias & Figueiredo, 2015). A balanced, woman-centered approach that encourages breastfeeding while validating diverse feeding experiences is therefore critical to maximizing benefits and minimizing harm, ensuring that breastfeeding promotion aligns with broader goals of maternal mental health, empowerment, and emotional resilience across the postpartum period (Uvnäs-Moberg et al., 2020).

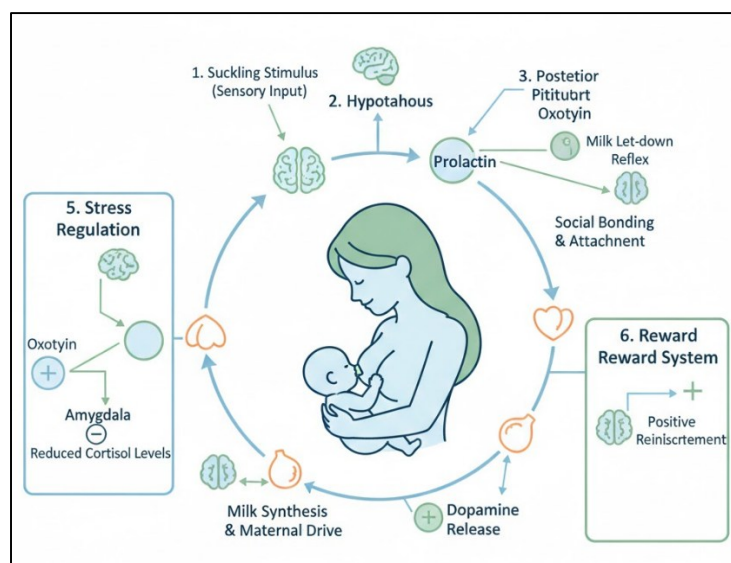


Figure 4. Neurohormonal pathways involved in breastfeeding-related bonding and stress regulation

6. Commercialization and the Infant Formula Industry:

One of the most significant and persistent challenges to optimal breastfeeding practices in the contemporary global context is the aggressive and sophisticated marketing of breast-milk substitutes, which continues to

undermine breastfeeding norms despite the existence of international regulatory frameworks (WHO, 2022). The International Code of Marketing of Breast-milk Substitutes was designed to protect families from inappropriate promotional practices and to ensure that infant feeding decisions are based on accurate, unbiased information; however, widespread violations persist, particularly in low- and middle-income countries where regulatory enforcement is weak and industry influence is strong (WHO, 2022). Transnational formula companies deploy extensive advertising campaigns that target parents during vulnerable periods such as pregnancy and the early postpartum phase, using emotional appeals that exploit fears about infant health, growth, and maternal adequacy (Grummer-Strawn et al., 2020). These marketing strategies frequently frame formula feeding as modern, scientific, or even superior to breastfeeding, thereby eroding confidence in human milk and normalizing reliance on commercial substitutes (Piwoz & Huffman, 2015). Claims about improved immunity, cognitive development, or specialized “clinical” formulations are often presented in ways that blur the line between marketing and medical advice, contributing to parental confusion and misinformation (WHO, 2022). In many settings, formula promotion occurs through healthcare channels including hospitals, clinics, and digital platforms, where branded materials, free samples, and sponsored training sessions further legitimize formula use in the eyes of parents and health workers (Sethi et al., 2018). Figure 5 illustrates common commercial strategies used by the infant formula industry, such as idealized imagery, pseudo-scientific language, and influencer marketing, which collectively shape social norms around infant feeding and create a perception of formula as a socially desirable choice (Pereira et al., 2024). These practices are particularly effective in contexts where breastfeeding support is inadequate, maternity leave is limited, and women face structural barriers to sustained breastfeeding, making formula appear as a practical and socially endorsed solution (Hernández-Cordero et al., 2021).

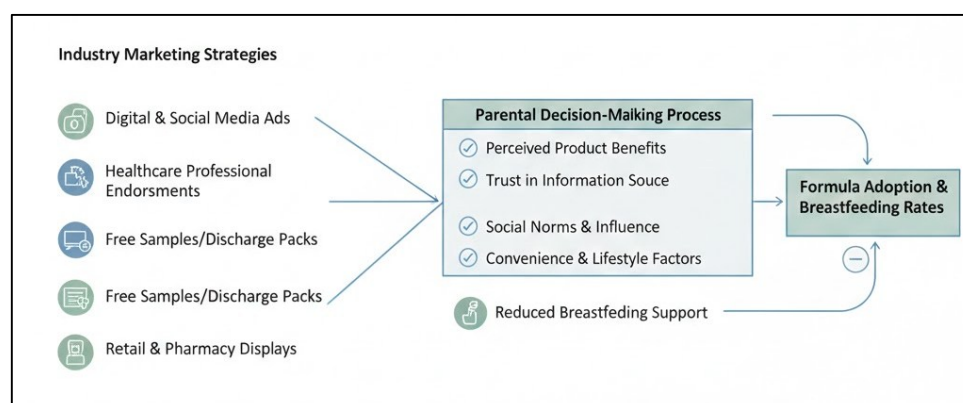


Figure 5. Marketing pathways through which breast-milk substitutes influence parental decision-making

The economic power of the global formula industry, which continues to grow rapidly and is estimated to be worth tens of billions of dollars annually, often exceeds that of national public health budgets, enabling companies to dominate media spaces and outspend breastfeeding promotion initiatives (Pereira et al., 2024). This imbalance creates an uneven informational environment in which parents are disproportionately exposed to persuasive commercial messaging while receiving comparatively limited access to skilled lactation counseling and evidence-based breastfeeding education (Rollins et al., 2016). Digital marketing has further intensified this challenge, as formula companies increasingly use social media, data analytics, and personalized advertising to reach parents directly, often circumventing traditional regulatory mechanisms and making surveillance of violations more difficult (WHO, 2023). Such strategies can be especially harmful in low- and middle-income countries, where unsafe water and sanitation conditions amplify the health risks associated with formula feeding, thereby exacerbating infant morbidity and mortality (WHO, 2022). Research indicates that exposure to formula marketing is associated with earlier cessation of breastfeeding, reduced exclusive breastfeeding rates, and diminished maternal confidence in milk sufficiency, even among mothers who initially intend to breastfeed (Patel et al., 2021). These effects undermine global public health goals related to child survival, nutrition, and maternal health, reinforcing inequities both within and between countries by shifting feeding norms toward commercial products rather than evidence-based breastfeeding support (Hernández-Cordero et al., 2021). Addressing this challenge requires not only stronger enforcement of the International Code but also proactive investment in breastfeeding support systems, public education campaigns, and protections against commercial interference in health policy (WHO, 2022). Without such measures, the dominance of formula marketing risks perpetuating a cycle in which commercial interests overshadow

evidence-based guidance, ultimately shaping infant feeding choices in ways that prioritize profit over population health (Grummer-Strawn et al., 2020).

7. Workplace Policies and Structural Barriers:

Inadequate maternity protection remains a critical barrier to sustained breastfeeding, as women who return to work early often face time constraints, lack of privacy, and insufficient workplace support, which collectively undermine their ability to continue exclusive breastfeeding for the recommended duration (Heymann et al., 2017). Paid maternity leave is among the most effective policy tools for improving breastfeeding outcomes, with evidence showing that longer leave duration is strongly associated with higher rates of breastfeeding initiation, exclusivity, and continuation into later infancy (Heymann et al., 2017). Beyond leave, workplace lactation spaces that provide privacy, hygiene, and refrigeration for expressed milk, along with flexible schedules that allow time for pumping, are essential components of supportive employment environments that enable breastfeeding continuation after returning to work (WHO, 2023). The availability of these protections not only increases breastfeeding duration but also reduces the physical and emotional stress experienced by working mothers, thereby promoting maternal well-being and productivity (Hesketh et al., 2021). A growing body of research indicates that supportive workplace policies can narrow breastfeeding disparities, particularly among low-income and marginalized women who are disproportionately employed in sectors with limited benefits and rigid schedules (Sriraman et al., 2020). In countries where maternity leave is short or unpaid, many mothers are forced to wean earlier than desired or to combine breastfeeding with suboptimal feeding practices, such as early introduction of formula or inadequate pumping routines, which can compromise milk supply and infant health (Pérez-Escamilla et al., 2016). Conversely, nations with generous maternity protection policies, including paid leave and workplace accommodations, consistently report higher rates of exclusive breastfeeding at six months and continued breastfeeding at one year, illustrating the powerful role of social policy in shaping health behaviors (Kaufman et al., 2018). Table 2 compares breastfeeding outcomes in countries with varying maternity leave policies, highlighting the stark differences in breastfeeding continuation rates that correspond with policy generosity and enforcement (UNICEF, 2021).

Table. 2: Relationship between Maternity Leave Duration and Breastfeeding Outcomes

Leave Duration	Exclusive Breastfeeding at 6 Months
<12 weeks	Low
12–26 weeks	Moderate
≥26 weeks	High

Fig. 6 further visualizes the relationship between maternity protection policies and breastfeeding continuation rates, demonstrating that even modest extensions of leave or improvements in workplace support can yield meaningful increases in breastfeeding duration (WHO, 2023). Importantly, maternity protection is not only a maternal health issue but also a broader economic and gender equity concern, as inadequate leave and workplace support can force women to choose between employment and optimal infant feeding, thereby limiting women's workforce participation and financial security (Kaufman et al., 2018). Policies that support breastfeeding through paid leave and workplace accommodations have been shown to provide a positive return on investment by reducing healthcare costs, improving child development outcomes, and enhancing maternal productivity (Rollins et al., 2016). However, policy implementation and enforcement remain uneven, and even in countries with formal protections, many women experience barriers due to employer noncompliance, lack of awareness of rights, and cultural norms that stigmatize breastfeeding in public or in the workplace (Sriraman et al., 2020). Additionally, informal workers, who represent a large share of the global female labor force, often lack access to any maternity benefits, underscoring the need for inclusive social protection schemes that extend beyond formal employment sectors (UNICEF, 2021). Addressing these gaps requires coordinated action across government, employers, and communities to ensure that maternity protection policies are comprehensive, accessible, and culturally supported, enabling women to breastfeed for as long as they desire without sacrificing economic stability or career advancement (WHO, 2023).

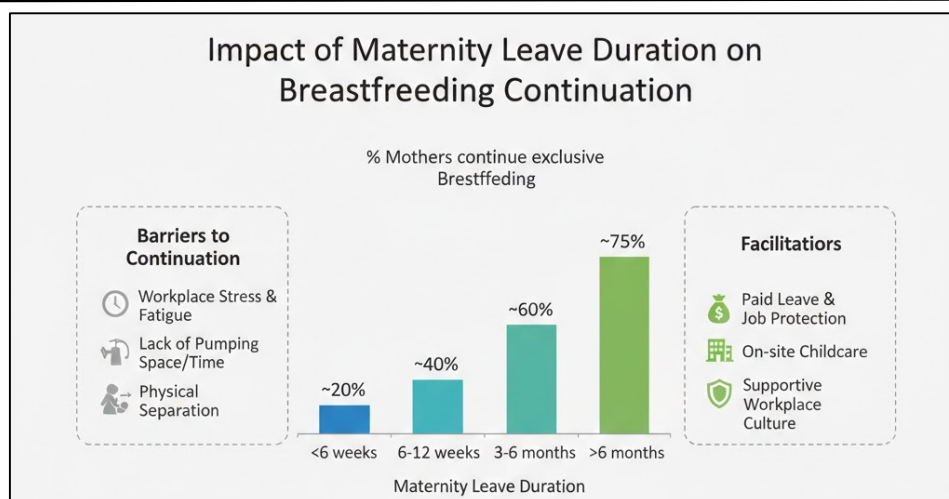


Figure 6. Association between maternity leave duration and breastfeeding continuation

Sociocultural Norms and Inequities

Breastfeeding practices are deeply shaped by cultural beliefs, gender norms, and social support systems, which collectively influence whether women feel empowered or constrained in their infant feeding choices (Smith et al., 2018). In many societies, breastfeeding is viewed through moral and social lenses that can either normalize it as a natural and valued practice or stigmatize it as inappropriate in public, thereby limiting women's ability to feed comfortably outside the home (Smith et al., 2018). In some contexts, public breastfeeding is socially discouraged or even considered indecent, which pressures mothers to avoid breastfeeding when away from private spaces and contributes to early weaning or reliance on formula (Labbok et al., 2019). Conversely, in other settings, breastfeeding may be framed as incompatible with modern womanhood, professional identity, or aspirational lifestyles, leading mothers to perceive formula feeding as a symbol of status, convenience, or emancipation (Sriraman & Kellams, 2016). Gender norms also shape caregiving expectations, with women often carrying the primary responsibility for infant feeding while simultaneously balancing work, household duties, and other caregiving roles, which can create unsustainable burdens and reduce breastfeeding duration (Pérez-Escamilla et al., 2016). Social support systems, including partner involvement, family attitudes, and community norms, play a critical role in sustaining breastfeeding, as encouragement from spouses and elders can buffer against challenges such as pain, low milk supply, and societal stigma (Gila-Díaz et al., 2020). In many cultures, grandmothers and extended family members exert strong influence over feeding decisions, and when their beliefs favor early supplementation or formula use, mothers may face pressure that undermines exclusive breastfeeding (Fischer et al., 2021). Health systems also reflect cultural and institutional norms, and when healthcare providers lack training in lactation support or hold biased views about breastfeeding, mothers may receive inconsistent or discouraging guidance during a crucial period (Rollins et al., 2016). Socioeconomic disparities further exacerbate inequities, as marginalized women particularly those with lower income, limited education, and precarious employment often encounter greater barriers to breastfeeding support, including insufficient maternity leave, lack of workplace accommodations, and limited access to skilled lactation care (Neves et al., 2021). Women living in poverty may also experience food insecurity, high stress, and crowded living conditions that complicate breastfeeding and increase vulnerability to formula marketing, which is often targeted toward low-income communities (Grummer-Strawn et al., 2020). Additionally, racial and ethnic inequities intersect with socioeconomic factors, with minority women frequently facing systemic discrimination in healthcare settings, lower-quality maternity care, and reduced access to culturally competent breastfeeding support (Bleich et al., 2019). Migrant women and those living in informal settlements may encounter language barriers, social isolation, and lack of community networks, which diminish opportunities for peer support and breastfeeding education (Sriraman et al., 2020). Figure 7 highlights these intersecting social determinants influencing breastfeeding outcomes, demonstrating how cultural norms, gendered expectations, and structural inequalities converge to shape feeding practices across different populations (Neves et al., 2021). Furthermore, the stigmatization of breastfeeding in public or the portrayal of breastfeeding as outdated can be reinforced through media representations and advertising, contributing to a social environment that discourages breastfeeding as a normative practice (Sriraman & Kellams, 2016). Addressing these multifaceted barriers requires interventions that go beyond individual behavior change and instead target community norms, gender equity, and structural supports, such as inclusive maternity protections, breastfeeding-friendly public spaces, and accessible lactation services (Pérez-Escamilla et al., 2016). Policies that engage partners and families, promote positive cultural narratives about

breastfeeding, and ensure that healthcare systems provide consistent, respectful, and evidence-based support can help mitigate stigma and empower women to breastfeed according to their goals (Gila-Díaz et al., 2020). Ultimately, improving breastfeeding outcomes demands a holistic approach that recognizes breastfeeding as a socially embedded practice shaped by intersecting determinants of health rather than solely a personal choice or medical issue (Neves et al., 2021).

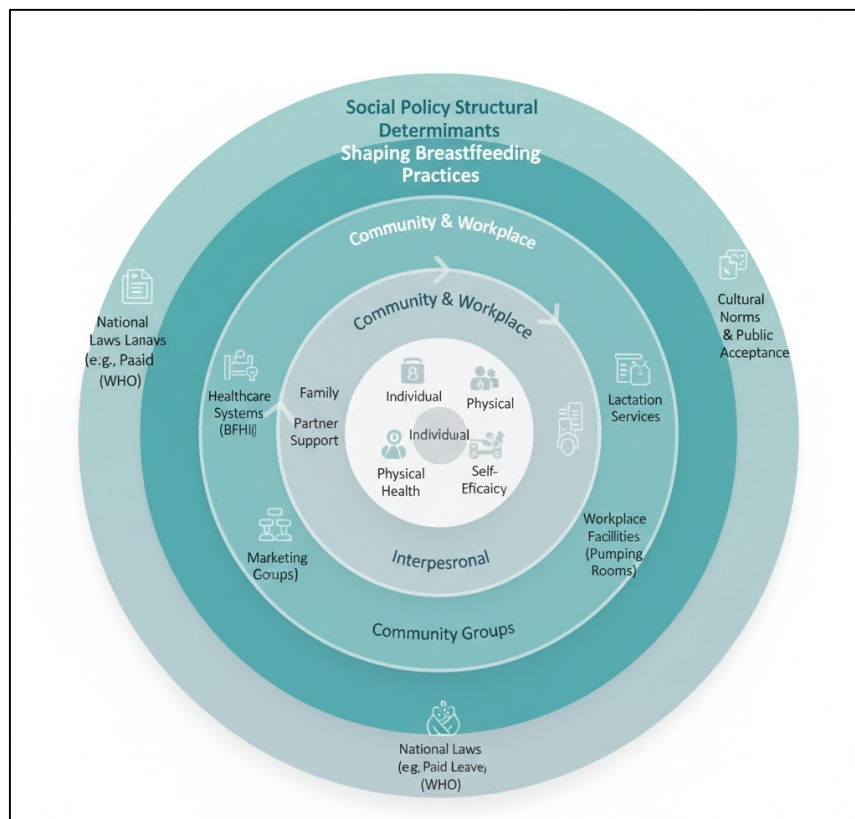


Figure 7. Social and structural determinants shaping breastfeeding practices

8. Environmental and Economic Implications:

Breastfeeding is not only a health issue but also an environmental one, as the production, packaging, distribution, and preparation of breast-milk substitutes contribute substantially to greenhouse gas emissions, water use, and waste generation, thereby amplifying the environmental footprint of infant feeding (Karlsson et al., 2019). The life-cycle environmental impacts of formula feeding begin with the intensive agricultural production of dairy or plant-based ingredients, which requires large quantities of land, water, and energy, and often involves high emissions of methane and other greenhouse gases from livestock systems (Serrano et al., 2020). Processing and manufacturing of infant formula further increase energy consumption through pasteurization, drying, and sterilization processes, while also generating industrial waste and contributing to air and water pollution (Horta et al., 2021). Packaging is another significant environmental burden, as formula products require multiple layers of materials such as cans, plastic liners, and plastic lids, all of which contribute to plastic pollution and are often not fully recyclable, thereby adding to the global waste crisis (Chaudhary & Kastner, 2021). Transportation and cold-chain logistics required to distribute formula globally further increase carbon emissions, particularly in regions where formula is imported over long distances, thereby extending the environmental impact beyond the production phase (Karlsson et al., 2019). In contrast, breastfeeding is a sustainable and zero-waste food system, relying on a renewable biological process that produces no packaging waste, requires no transportation, and has minimal additional resource use beyond maternal nutrition and care (Horta et al., 2021). Breast milk is produced on-demand, eliminating the need for energy-intensive preparation and sterilization of bottles, and reducing the risk of contamination that can occur with formula preparation, especially in areas lacking clean water and sanitation (Rollins et al., 2016). The environmental advantages of breastfeeding are particularly relevant in low- and middle-income countries where resource scarcity and waste management challenges are pronounced, and where reliance on formula can exacerbate local environmental and public health burdens (Serrano et al., 2020). Table 3 compares environmental impacts of breastfeeding versus formula feeding, illustrating that breastfeeding aligns with global sustainability goals by minimizing carbon emissions, conserving water, and reducing waste generation (Chaudhary & Kastner, 2021). From a

planetary health perspective, promoting breastfeeding contributes to climate change mitigation strategies by reducing demand for industrial food systems that are major contributors to greenhouse gas emissions (UNICEF, 2022). Moreover, the reduction in plastic waste associated with breastfeeding supports efforts to combat marine pollution and protect ecosystems, particularly given the growing global concern over microplastics and their impact on wildlife and human health (Jambeck et al., 2015). While breastfeeding does require additional maternal caloric intake and nutritional support, these demands are relatively modest compared to the environmental costs of formula production and distribution, and can be met through sustainable food systems and policies that support maternal nutrition (Horta et al., 2021). Policies that encourage breastfeeding therefore not only improve child and maternal health outcomes but also contribute to broader environmental sustainability objectives, including the United Nations Sustainable Development Goals related to responsible consumption, climate action, and clean water (Karlsson et al., 2019). Additionally, reducing reliance on formula can help alleviate the burden on energy and water infrastructures, particularly in regions facing climate-related resource constraints, by decreasing the need for water-intensive food production and energy-consuming manufacturing processes (Serrano et al., 2020). These environmental considerations reinforce breastfeeding as aligned with global sustainability goals and highlight the interconnectedness of infant feeding practices with ecological stewardship and long-term planetary health (UNICEF, 2022).

Table. 3: Environmental Comparison of Breastfeeding and Formula Feeding

Indicator	Breastfeeding	Formula Feeding
Carbon footprint	Minimal	High
Packaging waste	None	Significant
Water usage	Low	High

9. Policy Responses and Global Initiatives:

Global initiatives such as the Baby-Friendly Hospital Initiative (BFHI) and national breastfeeding strategies have demonstrated effectiveness in improving breastfeeding outcomes, particularly when implemented with high fidelity and supported by strong health system commitment (Perez-Escamilla et al., 2016). The BFHI, which promotes the Ten Steps to Successful Breastfeeding, has been associated with increased rates of early initiation, exclusive breastfeeding, and continued breastfeeding at later ages when hospitals adopt and sustain these practices (Munn et al., 2016). National breastfeeding strategies that combine public education, community support, and healthcare provider training also show measurable improvements in breastfeeding initiation and duration, especially when paired with monitoring systems and accountability mechanisms (Rollins et al., 2016). Figure 8 presents a policy framework integrating health, labor, and regulatory interventions, emphasizing that effective breastfeeding promotion requires coordinated action across multiple sectors, including healthcare, labor policy, and consumer protection (UNICEF, 2020). Health system interventions such as routine lactation counseling, skilled breastfeeding support in maternity wards, and integration of breastfeeding into primary care services contribute to sustained breastfeeding by addressing common barriers such as latch difficulties, pain, and milk supply concerns (McFadden et al., 2017). Labor policies, including paid maternity leave, workplace lactation spaces, and flexible schedules, are crucial for enabling mothers to continue breastfeeding after returning to work, and countries with stronger maternity protections consistently report better breastfeeding outcomes (Heymann et al., 2017). Regulatory interventions such as enforcing the International Code of Marketing of Breast-milk Substitutes help reduce exposure to aggressive formula marketing, which is known to undermine breastfeeding practices and influence infant feeding choices (WHO, 2022). However, policy implementation remains uneven across regions and countries, with significant variation in the adoption, enforcement, and sustainability of breastfeeding-supportive policies, often due to limited political will, inadequate infrastructure, and competing health priorities (Sinha et al., 2019). Industry lobbying poses a major challenge to effective policy enforcement, as formula companies frequently use marketing budgets, sponsorships, and political influence to weaken regulations and maintain market growth, particularly in low- and middle-income countries (Pereira et al., 2024). Insufficient funding for breastfeeding programs further undermines implementation, as breastfeeding promotion and support

require ongoing investment in training, monitoring, and community-based services that are often under-resourced in many health systems (Hernández-Cordero et al., 2021). Additionally, health workforce constraints such as staff shortages, limited lactation training, and high turnover can reduce the quality of breastfeeding support in facilities, weakening the impact of BFHI and other initiatives (Sriraman et al., 2020). Sociocultural factors, including stigma around breastfeeding in public and lack of partner and family support, also affect the success of policy interventions by shaping community norms and individual motivation (Smith et al., 2018). Monitoring and evaluation systems are essential for ensuring that policies translate into practice, yet many countries lack reliable data on breastfeeding indicators or fail to use data to drive improvements and accountability (UNICEF, 2020). When implemented effectively, however, integrated policy frameworks that combine healthcare, labor, and regulatory actions can create enabling environments that support breastfeeding across settings and life stages, from facility-based initiation to community-based continuation and workplace accommodation (Rollins et al., 2016). To strengthen global progress, governments must prioritize breastfeeding as a public health and social equity issue, allocate sufficient resources, and resist commercial interference while building multisectoral coalitions that uphold women's rights and child health (WHO, 2022). In doing so, breastfeeding can be supported as a normatively accepted, socially supported, and systemically enabled practice, contributing to improved health outcomes and broader sustainable development goals (UNICEF, 2020).

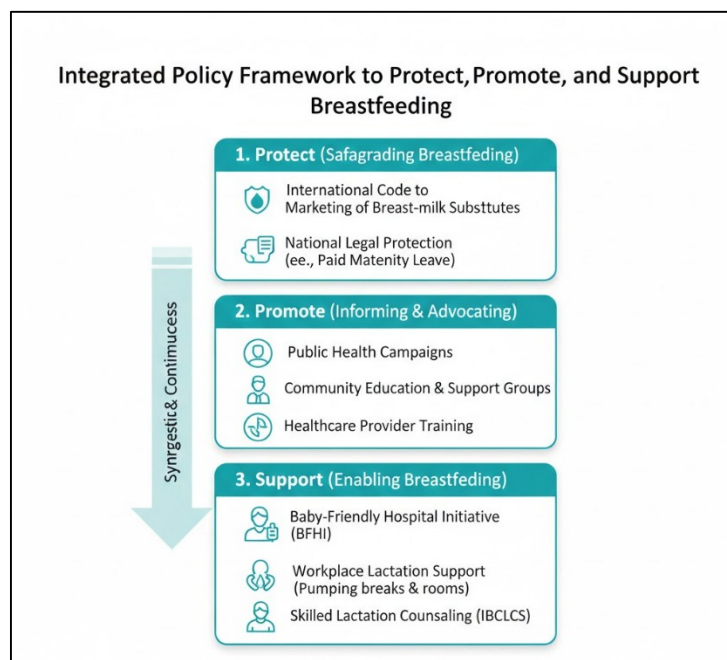


Figure 8. Integrated policy framework to protect, promote, and support breastfeeding

10. Conclusion:

Breastfeeding represents a cornerstone of infant and maternal health, offering unparalleled biological, psychological, economic, and environmental benefits that extend far beyond infancy and contribute to long-term wellbeing for both mother and child. Human milk provides optimal nutrition, immune protection, and microbiome support, while lactation supports maternal recovery and reduces the risk of chronic diseases, making breastfeeding one of the most effective public health interventions available. Yet, in a market-driven world, breastfeeding faces increasing challenges from commercialization, inadequate social protections, and cultural shifts that collectively undermine its practice. Aggressive marketing of breast-milk substitutes exploits parental anxieties and frames formula as a modern or superior option, while violations of the International Code of Marketing of Breast-milk Substitutes remain widespread and enforcement is often weak, particularly in low- and middle-income countries where regulatory oversight is limited and industry influence is strong. In addition, inadequate maternity protection remains a major barrier to sustained breastfeeding, as short or unpaid leave, lack of workplace lactation spaces, and rigid work schedules force many women to wean earlier than desired, reinforcing disparities in breastfeeding outcomes and limiting women's ability to combine employment with optimal infant feeding. Cultural beliefs and gender norms also shape breastfeeding practices, as stigma around public breastfeeding, perceptions of breastfeeding as incompatible with modern womanhood, and family pressures can discourage mothers and reduce their confidence, especially when social support systems are weak or breastfeeding is not normalized. Socioeconomic inequities further exacerbate these

challenges, with marginalized women facing greater barriers to breastfeeding support, limited access to lactation care, and heightened exposure to formula marketing, thereby widening health disparities. Breastfeeding is not only a health issue but also an environmental one, as formula production and distribution contribute substantially to greenhouse gas emissions, water use, and waste generation, while breastfeeding is a sustainable, low-carbon, zero-waste food system aligned with global sustainability goals. Addressing these challenges requires coordinated action across health systems, labor policies, regulatory frameworks, and community support structures, including strengthening hospital-based breastfeeding support, expanding paid maternity leave and workplace accommodations, enforcing marketing regulations, and promoting culturally sensitive education and peer support programs. Protecting breastfeeding is not merely a matter of individual choice but a collective responsibility, as societies that prioritize breastfeeding invest in healthier populations, reduced healthcare costs, gender equity, and environmental sustainability, ultimately creating conditions in which every mother and infant can thrive.

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