Breastfeeding and Breast Milk – from Biochemistry to Impact

A Multidisciplinary Introduction

Published by
Family Larsson-Rosenquist Foundation

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Foreword

I was 4 years old when my parents started to work in the field of breast pumps, back in 1962. The breastfeeding world looked different then as there was a strong belief it is possible to replicate everything that nature does – breastfeeding was at its low and formula was considered the norm. Still, my parents believed in the importance of breastfeeding and the importance of breast pumps to support mothers in need.

This belief in the life-long benefits of breastfeeding and breast milk eventually led us to establish the Family Larsson-Rosenquist Foundation.

When I started to become involved in the family business in the 1980s, it was clear to me as a trained scientist that we needed a scientific approach to better understand lactation. The first studies I did myself involved looking at the suction curves of babies at the breast. Through those studies a whole new world opened, and I learnt about the two distinct phases when an infant suckles at the breast – a stimulation and an extraction phase. Hence, I worked with our engineers to introduce these two phases to our breast pumps. This 2-Phase expression technology has today become the standard. This was also the start for our first research collaboration with Peter Hartmann and his team at the University of Western Australia.

Over the years our scientific network grew, as did our questions. I had many discussions with experts from different research fields including biochemistry, physiology, psychology and physics about breastfeeding and human lactation. It struck me how little knowledge there was in this field at the time and many thought that they knew all there was to know. It was clear to me that investment was needed to move the field forward - thus began our journey not only in product related research, but also in basic research to enlarge the knowledge base. This then led to some astounding findings: a new understanding of the anatomy of the lactating breast (updating knowledge that was over 150 years old) and the amazing discovery of stem cells in human milk. These findings showed us it was just the beginning – there is still so much more to know and learn.

Over the years our scientific network grew. We met and talked with many experts and multidisciplinary researchers in the field of breastfeeding, human milk and lactation, and the substantial long-term health benefits of breastfeeding and human milk for infants became clear.

As more evidence emerged, and with the realisation that research is key to ensuring that breastfeeding becomes the norm, it became my family's vision to help enable a world in which every child is granted an optimum start in life through the benefits of breastfeeding and human milk. This motivation was the signal needed for my family to establish the Family Larsson-Rosenquist Foundation, where science would take centre stage. I had the honour to be the founding president.

The vision for this book came following a visit to China in September 2013. Formula was dominating the market and breastfeeding rates at 6 months were extremely low (20.8%). One stop during this visit was the teaching hospital of Zhejiang Province (which has more than 50 million inhabitants). The dominance of formula was a big concern for the head of nursing research who was keen to reverse this trend – research was key to doing this. Her passion was clear, but one of her difficulties was getting an overview of research in the field of breastfeeding and human lactation. An example she shared, was the transfer of medications into the milk and she wished to do some research into this topic. I sent her Tom Hales' book about how drugs are transferred into mother's milk together with Hale & Hartmann's "Textbook of Human Lactation".

This is just one example of one hospital in a huge country that is facing an immense problem – formula dependence – with no practical solutions for change. I have found myself in many similar situations with would-be change-makers who are becoming increasingly interested in breastfeeding as the understanding of the health and economic benefits of human milk increases. The challenge they face is always the same: where and how can they access the research that will lead to solutions for change?

There are a lot of studies discussing the benefits of breastfeeding, but these mainly focus on the health issues and much of it is not standardised. Empowering individuals with the knowledge to make change, to increase interest at a local or even national level is key and I am therefore convinced that there is a growing need for a book which provides a multidisciplinary overview of breastfeeding and human milk. There are a lot of books written about 'how to' breastfeed, but the market lacks one that provides such diverse aspects. This book explores a plethora of key topics, and their practical implications. It is written by professionals who are experts within their respective fields and therefore provides a comprehensive, interdisciplinary view of the world of breastfeeding and human milk. It is designed to empower those interested in promoting the positive benefits of breastfeeding and human milk with the knowledge required to persuade decision-makers that this is the best option for improving short- and long-term health, decreasing health care-related spending and increasing productivity – the same values and goals my family stands for and which our foundation is pursuing on a daily base.

I hope that, one day soon, at home and when I travel, to find breastfeeding has again become the norm.

Zug (Switzerland), in July 2018
Michael Larsson

Preface

Authors from around the globe, each a specialist within their field have readily contributed to provide readers with a comprehensive overview of breastfeeding and human milk to encourage and empower interested parties to move breastfeeding higher up on the public health agenda.

There are many books available looking at "how to" breastfeed or focusing on a single topic within the field, others look at the biomedical aspects of milk, however none address a wide range of research disciplines to provide a truly multidisciplinary comprehensive overview: covering topics from physiology and psychology, culture, politics and economics to HIV and medications, NICU and human milk banking. The topics are varied, yet all relevant and important elements in the quest to increasing breastfeeding rates.

Multidisciplinary Introduction to Breastfeeding and Breast Milk – from Biochemistry to Impact is written for a wide and varied audience, ranging from nursing staff and lactation experts who have daily contact with mothers and babies, to health ministers who want to learn about how scaling up of breastfeeding can contribute to reducing their health care expenditure. It is also a key for doctors and researchers who have an interest in the topic yet are not fully aware of all the benefits that breastfed infants enjoy. Based on sound science but written in popular science style, ensuring an easy read, the book provides a comprehensive and solid foundation including sources and references. It also features a unique in-depth scientific glossary of lactation that provides definitions for a plethora of important terms of breastfeeding and human milk that are science based and reviewed by acknowledged experts in the field.

The book aims to provide a holistic overview, and is divided into four parts with individual introductions. As each chapter covers a topic in depth, it can be also be read independently. Furthermore, the book can be used as a Dip-In-and-Out book as each chapter provides a summary of the topics covered at the beginning as well as a list of key findings and messages at the end of the chapter. This allows the reader to quickly identify topics and peruse key findings to identify areas of specific interest and to read the book in a more targeted manner.

Overall this book provides a unique insight into a wide range of aspects of breastfeeding, human milk and lactation, empowering individuals with the knowledge to increase public interest and to work towards the goal of making breastfeeding the norm again.

Zug (Switzerland), in July 2018
Göran Larsson

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Setting the Scene

1 Introduction

Peter E. Hartmann, E/Prof, PhD, BRurSc

Historically, there were only two options for infant nutrition that were compatible with infant survival: a mother's milk or a wet nurse's milk. Agricultural developments and the resulting domestication of animals led to an alternative – animal milk. However, most babies fed animal milk did not survive. This was largely due to its inappropriate composition for humans (e.g. cow's milk has too much sodium and casein) and poor hygiene. Today, the World Health Organization (WHO) recommends infants be exclusively breastfed beginning one-to-two hours after birth and continuing up to six months of age, when they can be gradually weaned over the next 2 years and beyond.

The first section of this book sets the scene with background information that will help readers learn why breastfeeding is so vital. It explains how the human body works to produce such a complex bioliquid for nurturing infants. It also offers a glimpse into the world of data collection on breastfeeding and human milk.

Part I (see chapter 2) begins with a chapter from Leith Greenslade, CEO, JustActions LLC, New York. She provides insight into the importance of breastfeeding, and how producing breastmilk – an extraordinary protective and nutritional substance – for the health and development of their babies empowers mothers. She explores how breastfeeding is important for global health and sustainable development. Finally, Greenslade outlines the many issues surrounding breastfeeding, such as the lack of acceptance of breastfeeding's importance, the collective failures by society and science to respond to poor breastfeeding outcomes, and the dearth of investment in breastfeeding innovations to help women balance the needs of breastfeeding and returning to paid employment, all of which are yet to be resolved.

Information – data – is the key to understanding the myriad issues linked to breastfeeding and to developing the policies and interventions that will resolve them. Maria Quigley, Professor of Statistical Epidemiology at the National Perinatal Epidemiology Unit, University of Oxford, provides an overview on collecting breastfeeding-related data and how it is processed (see chapter 3). Such data is used to compare infant feeding patterns in different countries and settings, and also to track progress towards achieving longer-term global health targets. Without consistent and comparable statistical data, it would be impossible to formulate and assess interventions aimed at overcoming the barriers to breastfeeding. Precise data definitions are required to ensure this consistency for both surveys and epidemiological studies. Professor Quigley addresses questions about the type of data needed to evaluate the long-term effects of breastfeeding in both mothers and infants, the quality of reporting on exclusive breastfeeding, what data should be collected for matters of economics, policy formation, education and implementation, who collects the data and how is it collected. Finally, she indicates where appropriate, randomized controlled trials are required to confirm observational studies and provide consistent and comparable statistical data.

In chapter 4, Ms Melinda Boss, the team leader of a multidisciplinary group developing evidence-based protocols, and I discuss the issues associated with creating a common understanding of human lactation in relation to how breastfeeding actually works from an anatomical and physiological perspective. The authors also discuss the development of related research – until the beginning of this century, the only definitive research into the anatomy of the lactating human breast was conducted in 1840. They show how this absence of research has greatly impaired advancing understanding of the anatomy and physiology of human lactation, such as the fact that the lactating breast is a complex metabolic organ that accounts for approximately one third of a mother's daily resting energy output. Next, the authors outline the initial phase of the lactation cycle – an extended process beginning with conception, followed by distinct stages during pregnancy and the first three days

after birth. This overview is followed by a summary of the established lactation phase, where milk synthesis is regulated by an autocrine, or local, control that responds to an infant's appetite. The cycle ends with weaning and the involution of the gland once milk removal has ceased.

Part I (see chapter 5) concludes with Professor Berthold Koletzko, Dr. of Haunerschen Children's Hospital and Kinderpoliklinik of the Ludwig-Maximilians-University, Munich, answering the question, "Why breastfeed?" He helps readers understand the evolution of lactation and the delicate balance between limiting energy costs to mothers while maximising infant survival. In this context, he touches on the considerable data supporting the health effects and benefits of breastfeeding for both mothers and infants. For example, women who breastfeed may benefit from enhanced regression of fat that accumulates during pregnancy and reduced risk of mammary and ovarian carcinomas. He explains how infants who are breastfed have reduced risk of infections such as acute otitis media and acute gastroenteritis, as well as disorders later in life, such as mammary and ovarian carcinomas. Furthermore, he discusses initial evidence of the small but important benefit breastfeeding can have on a child's later cognitive ability, which is associated with significant advantages connected to educational achievement and income generation. He also touches on breastfeeding's role in strengthening mother-infant bonding. Professor Koletzko concludes by explaining how such findings should prompt health care professionals around the world to support women's health before pregnancy, during pregnancy and throughout lactation as each phase has a direct impact on lactation outcomes.

2 Breast Milk, Global Health and Sustainable Development

Leith Greenslade, MPP, MBA

Expected Key Learning Outcomes

- Why breastfeeding is so important
- How breastfeeding can help reduce the inequalities in health
- The health and economic benefits from increasing breastfeeding rates
- Reasons why mothers do not breastfeed despite all the evidence from research demonstrating the benefits
- The required change of policy focus needed to support a global increase in breastfeeding rates

2.1 The Importance of Empowered Mothers

Nature has empowered mothers with control over the production and distribution of an extraordinarily protective substance for the health and development of their babies — breast milk. This evolutionary innovation provides all of the nutrition an infant needs for the first six months of life and affords protection from infectious diseases, reduces the risk of sickness and death, and contributes to healthy digestive and brain development well into early childhood.

Unlike the vast majority of health interventions, breast milk is wholly owned and operated by mothers who function as "doctors" administering their "medicine". To unleash the protective powers of breast milk, mothers must not only be knowledgeable about the benefits of breast milk. They must also be freely able to exercise their choice to breastfeed, unfettered by external barriers. If mothers cannot breastfeed due to sickness or absence, they should be able to ensure that their babies have access to their own breast milk and, where that is not possible, to donor breast milk from the newborn period onwards.

It is critical that development actors confront the reality that for almost all mothers — an estimated 140 million women give birth every year — breastfeeding is not always a choice. Depending on the severity of the barriers, a mother may be so constrained by forces beyond her control (e.g., lack of education, lack of family support, the need to earn an income) that she cannot exercise a preference to breastfeed. For many tens of millions of mothers, breastfeeding is not possible in the environments in which they live. For these women, reducing or removing the external constraints is what will ultimately lead to sustained increases in breastfeeding.

Women facing the most significant barriers to breastfeeding are also most likely to live in communities where the costs of not breastfeeding fall most heavily on children. These are the populations where very low breastfeeding rates coexist with very high rates of newborn and child sickness and death. Empowering mothers in these high-risk environments to exercise a real choice to breastfeed in supportive homes, workplaces, and public spaces should be the primary focus of development efforts to increase breastfeeding rates.

2.2 The Benefits of Breast Milk

In the past 15 years the health benefits of breastfeeding have become extremely well known and extensively promoted. There is consensus among the global health community that breast milk confers its powerful protective properties on children by providing all of the nutrients, vitamins, and minerals children need in the first six months of life, alongside antibodies that combat infectious diseases, especially diarrhoea and pneumonia [1],

[2], and enzymes for optimal digestion. There is now widespread acceptance that the health benefits of breastfeeding continue well into early childhood, and potentially beyond. The benefits of breastfeeding for women include reduced risk of pregnancy and potentially lower lifetime risks of certain cancers, obesity, diabetes, and heart disease [3].

Several *Lancet* series on maternal, newborn, and child health and nutrition have laid out the evidence for the benefits of breast milk. The Maternal and Child Undernutrition Series [4], the Maternal and Child Nutrition Series [5], the Childhood Pneumonia and Diarrhoea Series [6], the Every Newborn Series [7], and the Breastfeeding Series [8] all cite evidence that breastfed babies are much more likely to survive the first six months of life [9], that initiation of breastfeeding within 24 hours of birth could reduce the risk of newborn death by 43% of all newborn deaths [10], [11], [12] and that breastfeeding could prevent 823,000 child deaths and 20,000 breast cancer deaths annually [13]. Other sources accord with these findings, including the Born Too Soon Report, which stresses the importance of breast milk for preterm babies [14], and the Global Burden of Disease Study 2016, which ranks "suboptimal breastfeeding" as a leading behavioural risk factor in child death, especially across African and Asian countries [15]. According to this body of evidence, no other single intervention has the power to prevent newborn and child deaths at the scale of breast milk.

There is less consensus about the long-term health and related benefits of breastfeeding for both breastfeeding mothers and breastfed infants. The many studies that report adult health benefits including reductions in heart disease, diabetes, and cancers; cognitive improvements including higher IQ; and even economic gains including higher educational performance and income [16] all suffer from methodological weaknesses as they are based on cross-sectional retrospective studies rather than randomised control trials. A recent meta-analysis of these studies cautioned that these methodological challenges limit the ability to draw firm conclusions [17], [18].

The 2016 *Lancet* Breastfeeding Series quantified the impact of these health and development benefits on healthcare costs and economic growth, reporting that increases in breastfeeding rates could save US$400 million in healthcare costs in the US, UK, Brazil, and China alone, and inject US$300 billion into economies from more productive workforces [19].

2.3 Breastfeeding as an Equity Strategy

Children born to low income families in high-risk environments disproportionately benefit from the special protective properties of breast milk because they are more likely to be exposed to infections exacerbated by poor living conditions and less likely to access quality healthcare as formal health services so often fail to reach them. A recent study reported that a 10% increase in breastfeeding prevalence across all households resulted in a larger absolute reduction in child deaths in the poorest households [20]. The authors concluded that breastfeeding is better positioned to reduce wealth-related child health inequalities than other interventions.

Although breastfeeding is one of the few health interventions where the gaps in coverage between high and low income households are narrow in low income countries, early and exclusive breastfeeding rates among poor families remain very low [21]. Globally, just 40% of infants from the poorest households are exclusively breastfeed for the first six months of life, and in many countries with the highest child mortality breastfeeding rates are even lower [22]. For example, the ten countries with the highest child mortality rates all have exclusive breastfeeding rates below 50% (▶ **Table 1.1**), and several have rates below 20%. Further, eight of the ten countries with the largest numbers of child deaths have exclusive breastfeeding rates below 50% (▶ **Table 1.2**). These include India, Nigeria, Pakistan, China, Democratic Republic of Congo, Indonesia, Angola, and the Philippines.

Despite recent improvements in breastfeeding rates in some countries, the rate of progress overall has been slow over the last 25 years [23].

▶ **Tab. 1.1** Breastfeeding rates in countries with the highest child mortality rates, 2015.

Country	Child Mortality Rate 2016	% Early Breastfeeding (0–1 hour) 2008–2015	% Exclusive Breastfeeding (0–6 months) 2008–2015
Angola	157	55	No data
Somalia	133	26	5
Chad	127	29	3
Central African Republic	124	44	34
Sierra Leone	114	54	32
Mali	111	46	34
Nigeria	104	33	17
Benin	98	50	41
Democratic Republic of Congo	94	52	48
Cote d'Ivoire	92	53	23
Niger	91	53	23
Global Average	41	43	40

Source: World Bank and UNICEF, latest.

▶ **Tab. 1.2** Breastfeeding rates in countries with the highest newborn and child deaths, 2015.

Country	Number Newborn Deaths (0–1 month, 2015)	Number Child Deaths (0–5 years, 2015)	% Early Breastfeeding (0–1 hour)	% Exclusive Breastfeeding (0–6 months)
India	696,000	1,201,000	41	62
Nigeria	240,000	750,000	33	17
Pakistan	245,000	432,000	18	38
China	93,000	182,000	41	28
Democratic Republic of Congo	94,000	305,000	52	48
Indonesia	74,000	147,000	49	42
Angola	53,000	169,000	55	No data
Sudan	39,000	89,000	73	55
Kenya	34,000	74,000	58	61
Philippines	30,000	66,000	50	27

Source: UNICEF, 2015 and World Bank, latest.

Among the 33 countries with the slowest rates of reduction in child mortality, only four have exclusive breastfeeding rates above 50% – Burundi, Togo, Papua New Guinea, and Lesotho [24]. This lack of improvement in breastfeeding rates in countries struggling to prevent child deaths implies that there are considerable equity gains to be made in targeting their most vulnerable populations for breastfeeding improvements, particularly in the countries with very low vaccination rates [25]. To

leverage the equity impact of breastfeeding in full both within and between countries, it is critical that the global development community prioritises breastfeeding support in the populations with the lowest absolute rates of breastfeeding and breastfeeding progress, the weakest health infrastructure, and the highest burdens of newborn and child death.

2.4 The Cost-Effectiveness of Breastfeeding

Like many prevention efforts, breastfeeding investments are highly cost-effective. The 2013 Lancet Maternal and Child Nutrition Series reports that breastfeeding promotion compares very favourably with other nutrition intervention packages and has the power to reduce hundreds of thousands of child deaths at an annual cost per life saved of $US175. Of ten single nutrition interventions assessed by The Lancet, only the management of severe acute malnutrition and preventive zinc supplementation saved more lives than breastfeeding promotion, and of four intervention packages modelled, only the management of acute malnutrition saved more lives at lower cost than breastfeeding promotion [26].

Further, the 2014 Lancet Newborn Series reported that the earlier breastfeeding support services reach mothers after birth, the greater the impact on newborn health and breastfeeding duration. The Series cited that education and counselling can improve exclusive breastfeeding rates by 43% the day after birth and by up to 30% in the first month after birth. Kangaroo mother care, a strategy that improves the health of babies born too small, also encourages breastfeeding, with studies showing a 27% increase in breastfeeding rates at one to four months after birth and an increased breastfeeding duration. This body of research estimates that where a specific population can achieve 90% coverage of breastfeeding promotion exclusive breastfeeding rates can increase by 15% in newborns and by 20% in children aged one to five months [27].

Yet despite the evidence of the cost-effectiveness of breastfeeding support programmes, international development spending on breastfeeding programmes has never been high. Indeed, it has been declining since the 1990s and is now at historically low levels relative to other health prevention areas, most notably vaccines and insecticide-treated bed nets [28]. The relatively high level of investment in vaccines and in malaria prevention is one of the reasons why they are responsible for preventing such a large proportion of child deaths since 1990 in so many countries [29]. The fact that breastfeeding contributed so little to the 50% reduction in child deaths achieved over the life of the Millennium Development Goals begs a critical question: Could we have actually achieved the 66% reduction in child deaths required to achieve Goal 4 with greater investments in breastfeeding promotion and support?

2.5 Breastfeeding's Poor Performance

Despite the significant health and equity benefits of breastfeeding, and the cost-effectiveness of breastfeeding support services, rates of breastfeeding in most countries fall below the World Health Organization's (WHO) recommendations (early initiation of breastfeeding within one hour of birth, exclusive breastfeeding until 6 months of age, and continued breastfeeding until 2 years of age or older), and the World Health Assembly's target of at least 50% exclusive breastfeeding [14]. Globally, just 40% of babies are breastfed exclusively for the first 6 months and 43% in the first hour after birth, far below the coverage rates achieved by other child survival interventions such as vaccines (86%), Vitamin A (72%), and skilled birth attendance (78%). Currently, only 32 countries have achieved the 50% exclusive breastfeeding target and many countries struggling with high burdens of newborn and child mortality have rates far below 50%.

Progress in closing the high breastfeeding coverage gaps has also lagged other areas of global health. According to the Countdown to 2015 Final

Report, exclusive breastfeeding rates are increasing by just one percentage point a year and in most Countdown countries the proportion of children who are still breastfed at ages of 12 to 15 months and of 20 to 23 months is actually falling. As a result, just 13% of the breastfeeding coverage gap has been closed, putting breastfeeding well behind vaccination, malaria prevention and treatment, safe drinking water, and reproductive health advances.

An important new analysis of breastfeeding progress appears in the 2015 Global Nutrition Report [30] and finds that only 32 of 78 countries with sufficient data on breastfeeding are on-course to meet the 50% coverage target. Ten countries are off-course but making progress, 30 are off-course and making no progress, and six countries show large reversals in rates (Cuba, Egypt, Mongolia, Nepal, Turkey, and Kyrgyzstan). Of great concern is that some of the countries with the largest burdens of child death are among those off-course (e.g., Nigeria, Pakistan, Ethiopia, Bangladesh, Tanzania, Mozambique, Malawi, Cameroon, and Ivory Coast). The Report decries the lack of progress on breastfeeding rates and calls for urgent action to prioritise the collection of breastfeeding data in the 115 countries where it is lacking.

On a more promising note, the Global Nutrition Report also draws attention to countries that have made strong breastfeeding progress in recent years, especially India, which has doubled its exclusive breastfeeding rate (from 34% to 62%) over an eight-year period. The United Nations International Children's Fund (UNICEF) and the World Breastfeeding Trends Initiative also highlight several countries for their recent breastfeeding progress, although some of their high performers are now in the off-course category, according to the Global Nutrition Report [31]. The wide variation in exclusive breastfeeding rates (ranging from 0% in Chad to 87% in Rwanda) is also cause for optimism as it shows that even in the most challenging environments, breastfeeding advances are possible.

2.6 Barriers to Breastfeeding

Poor breastfeeding performance in a majority of countries coexists with generally high levels of awareness about the benefits of breastfeeding, especially among mothers. Surveys repeatedly show that women know 'breast is best' and self-report a strong preference to breastfeed. The wide gaps between women's preferences to breastfeed and breastfeeding rates suggest the existence of a significant 'know-do' gap and imply that women face steep barriers to breastfeeding in most countries. Understanding the nature of these barriers, how they operate in specific contexts, and how to neutralise them is one of the most critical challenges in child health and development.

Individual country surveys and the few multi-country surveys of women's attitudes to breastfeeding that exist attest to the 'know-do' gap in breastfeeding behaviour. A 2011 seven-country survey by the Philips Center for Health and Wellbeing found that although more than nine in ten of the 4,000 mothers surveyed wanted to breastfeed, only a minority were able to do so exclusively for six months [32]. A range of barriers from perceived breast milk insufficiency, to pain and discomfort, to transition to work, and fear of breastfeeding in public were cited. A 2014 nine-country study by Lansinoh found that most of the 13,000 mothers surveyed wanted to breastfeed exclusively but did not, citing pain and discomfort, lack of time, the difficulty of pumping at work, and public embarrassment as major reasons [33]. In addition, studies from several low income countries point to cultural beliefs about the importance of non-breast milk feeding for spiritual 'protection' and other purposes as significant barriers to exclusive breastfeeding [34].

Many non-survey based studies postulate other barriers to breastfeeding that focus on the marketing and availability of breast milk substitutes, especially infant formula [35]. These studies, many of them conducted by civil society organisations, point to lax implementation of the WHO Code of Marketing of Breast-milk Substitutes as a major barrier, arguing that aggressive marketing practices encourage mothers to use infant formula as a partial or complete substitute for breastfeeding.

They assume that if the companies that manufacture infant formula are prevented from marketing it, demand for infant formula would fall and breastfeeding would rise. However, the fact that so many of the 39 countries that have fully adopted the WHO Code have low exclusive breastfeeding rates suggests that the marketing of infant formula is not a major barrier to breastfeeding on its own, and full Code implementation does not reduce the underlying demand for breast milk substitutes.

A recent analysis of the implementation of the Code points to four countries that have strengthened Code implementation as best practice – Armenia, Botswana, India, and Vietnam [36]. However, only one of these countries (Vietnam) is described as on course with respect to breastfeeding progress in the Global Nutrition Report. The Access to Nutrition Index [37] offered the first independent assessment of Code compliance by five companies (Danone, FrieslandCampina, Groupe Lactalis, Heinz, and Nestlé) in 2016. It concluded that significant progress could be made if WHO were to clarify further its definition of products covered by the Code, and set out clearer definitions of some of the terms used in the Code as they were not all interpreted consistently by stakeholders.

It is likely that demand for alternatives to breast milk is driven more by the range of barriers identified in the consumer survey data than by the availability of infant formula. Further, it is even possible that restricting access to infant formula without addressing these underlying barriers could result in greater use of other substitutes (e.g., water, animal milk, tea, and foods) or reduced infant feeding entirely. If a number of powerful forces (e.g., rising female labour force participation and gender equality) are placing downward pressure on breastfeeding rates and these forces become even stronger as countries develop, unlike most other health indicators, breastfeeding rates will decline as countries develop regardless of special intervention. Most of the top ten countries in the Human Development Index have very low exclusive breastfeeding rates [38].

2.7 A Collective Failure to Respond

Despite a plethora of policy reports advocating the benefits of breastfeeding, and several special initiatives launched since the Innocenti Declaration on the Protection, Promotion and Support of Breastfeeding was signed by 30 governments and several UN agencies in 1990 [39], few programmes have systematically targeted the range of breastfeeding barriers faced by women. This is especially so in populations where breastfeeding could contribute significantly to newborn and child survival. An independent analysis conducted for UNICEF culminated in a landmark report, Breastfeeding on the Worldwide Agenda, that categorised the breastfeeding landscape as "policy-rich and implementation-poor" and called for urgent action to "transform the token attention breast-feeding often receives into a non-negotiable commitment to deliver a comprehensive package of health and nutrition interventions at scale" [40].

The few large-scale investments in breastfeeding programmes, especially the US Agency for International Development (USAID)-funded LINKAGES Project (1996–2006) [41] and the Bill & Melinda Gates-funded Alive & Thrive programme (2009–2015) [42], have demonstrated that dramatic increases in exclusive breastfeeding rates are possible when several barriers to breastfeeding are targeted simultaneously. Of special note are the results from the Alive & Thrive programme in Bangladesh and Vietnam where exclusive breastfeeding rates rose from 49% to 86% and from 19% to 63%, respectively, among populations of millions of women. Whether these impressive increases can be sustained over time remains to be seen and the subsequent decline in the exclusive breastfeeding rates in several of the LINKAGES sites after the programme ended urges caution. However, the results of these programmes are an endorsement of the "Breastfeeding Gear" model, which argues that successful breastfeeding programmes should function like a "well-oiled engine" with several factors working in synchrony and coordination [43].

The results of successful programmes like Alive & Thrive suggest that development agencies need to go beyond breastfeeding promotion and single-

barrier focused initiatives to impact breastfeeding rates substantially. With a raft of new breastfeeding supportive policies and advocacy platforms that now includes the Every Newborn Action Plan [44], the new Global Strategy for Women's, Children's and Adolescents' Health [45], the Scaling Up Nutrition (SUN) movement, and the new Global Breastfeeding Collective, supported by UNICEF and the WHO with funding from the Bill & Melinda Gates Foundation, the time is ripe for large, multi-country investments that translate these policies and mobilise these platforms to action. It will be especially important to target breastfeeding action to newborns as they have been poorly served by existing breastfeeding initiatives despite the evidence that increases in early initiation have the potential to prevent hundreds of thousands of newborn deaths each year [46]. It is particularly tragic that the babies who could benefit most from breast milk, i.e., sick and vulnerable newborns, have never been the subject of special efforts by development actors to increase their access to their mother's milk or to donor milk through human milk banks. The WHO Baby Friendly Hospital Initiative has never targeted sick and vulnerable newborns.

The widespread failure of all development actors – governments, business, and civil society – to invest adequately in removing or reducing the full range of barriers to breastfeeding experienced by mothers is now a contributing factor in the downward pressure on breastfeeding rates in most countries. With several substantial funding platforms now available for large-scale nutrition investments, including the Global Financing Facility in Support of Every Woman, Every Child, the Power of Nutrition Fund, and the 2016 Nutrition for Growth Summit, a critical challenge for the breastfeeding community will be to attract a fair share of this investment for high impact breastfeeding initiatives.

2.8 Investments in Breastfeeding Innovations

Identifying compelling investment opportunities with the potential to increase early and exclusive breastfeeding rates in countries where gains will directly translate into newborn and child survival, reduced healthcare costs, and economic gains is now an urgent priority. The most promising solutions will be able to neutralise one or more of the barriers to breastfeeding and lower the rising costs women face as countries develop. The most investment-worthy innovations will have a proven capacity to: (a) increase breastfeeding initiation within an hour for both home and hospital births, (b) ensure even the most vulnerable newborns have access to human milk, (c) improve women's self-confidence about the adequacy of their milk supplies, (d) reduce breastfeeding pain and discomfort and improve technique, (e) reduce breastfeeding time constraints, especially by extending paid parental leave, and (f) create breastfeeding-friendly workplaces, homes, and public spaces.

Examples of specific innovations in each of these categories include cash and non-cash incentives for early initiation at home and at hospitals in the form of direct payments to mothers and/or facilities for high early initiation rates. Widespread access to donor breast milk for vulnerable newborns could be provided through a network of regulated human milk banks located at facilities and in the community [47]. New individual measures of breast milk supply could be developed, with mothers receiving a medical assessment of their supply to build their confidence in the early weeks and months that substitutes are unnecessary [48]. If substitutes are necessary, donor breast milk could be provided through human milk banks. Immediate access to lactation consultants in the home via phone apps could help with technique and pain challenges. Access to new generations of affordable, easy-to-use breast pumps specially designed for low resource settings could reduce the time constraints many women experience, and new methods of pasteurisation in the absence of refrigeration could lengthen the shelf-life of pumped breast milk.

A new system of employer incentives and disincentives could standardise the availability of regular breastfeeding breaks alongside specially equipped rooms to pump and store breast milk at work [49]. On-site infant care where mothers can actually breastfeed their babies during work may be even more effective. Public spaces could be transformed by government-funded breastfeeding rooms or "pods" attached to public buildings (e.g., schools, transport hubs, and libraries). Social business franchises could offer women a private place to breastfeed throughout the day, even for a small fee, similar to the way sanitation facilities are being provided in many urban areas in Africa and South Asia [50]. Where these workplace innovations occur alongside expansions in the duration of paid parental leave, the impact on breastfeeding rates could be transformative.

In 2015, the Breastfeeding Innovations Team was formed to strengthen the pipeline for breastfeeding innovations. The Team comprises a global network of more than 200 organisations and individuals committed to accelerating the development and adoption of innovations with the greatest potential to increase access to breast milk for babies, especially the most vulnerable. It works in support of the UN Secretary-General's Every Woman, Every Child movement, the Every Newborn Action Plan, and the Global Breastfeeding Advocacy Initiative. More groups like these with the capacity to crowd in a community of breast milk innovators and mobilise support from investors will be critical.

2.9 Breaking Breastfeeding Barriers: a Call to Action

To achieve the greatest increases in breastfeeding rates, innovations will need to benefit mothers living in high-risk environments disproportionately. This is especially relevant to the populations in sub-Saharan Africa and South Asia where breastfeeding increases have the potential to close newborn and child survival gaps. As the specific barriers to breastfeeding differ across populations, innovations will need to be very sensitive to context. Accordingly, development actors should join forces with the agencies able to develop the necessary innovations in a new multi-stakeholder partnership with a singular aim: to increase early and exclusive breastfeeding rates dramatically in populations where breastfeeding gains can contribute the most to national child health goals.

As such, the Breaking the Barriers to Breastfeeding Partnership would enlist all UN agencies, civil society, and corporate actors with the capacity to contribute to population-wide breastfeeding increases in the following 15 countries: India, Nigeria, Pakistan, China, Democratic Republic of Congo, Indonesia, Cote d'Ivoire, Sudan, Kenya, the Philippines, Chad, Somalia, Central African Republic, Sierra Leone, and Mali. These agencies would work with national, state, and local governments to assess the major barriers to breastfeeding among the sub-national populations suffering the greatest burdens of newborn and child deaths, and then develop integrated strategies to reduce or remove the barriers systematically over a ten-year period. The Partnership would make full use of the mechanisms available to governments (legislation, tax and transfer systems, and direct service delivery), to business (marketing, employment policies, product design, and direct service delivery) and to civil society (advocacy, direct service delivery, and social mobilisation) as levers to neutralise specific barriers to breastfeeding.

The Partnership would be financed collaboratively with contributions from governments, UN agencies, business, and civil society with support from high-profile platforms like the Global Financing Facility. High-profile advocacy platforms such as the UN Secretary-General's Every Woman, Every Child movement would champion the initiative. It would build on the lessons learned from the most successful breastfeeding programmes, especially Alive & Thrive, and on engagement of groups like SUN which have already rallied many partners, including a strong group of companies, to support breastfeeding improvements [29].

2.10

Breastfeeding and the Sustainable Development Goals

In September 2015, the global policy environment for public health profoundly changed with endorsement of the Sustainable Development Goals at the United Nations General Assembly. At this historic gathering, 194 governments pledged to achieve, by 2030, 17 of the most ambitious development goals ever contemplated, including two goals directly related to breastfeeding [51]:

- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- Goal 3: Ensure healthy lives and promote well-being for all at all ages.

It is of great concern that the current World Health Assembly target for breastfeeding — achieving 50% coverage of exclusive breastfeeding by 2025 — does not match the ambition of the Sustainable Development Goals and falls far below coverage targets for other lifesaving interventions. Not only will the 50% target fail to inspire further gains in the 34 countries with exclusive breastfeeding rates above 50%, but it will not drive breastfeeding to the levels required for maximum impact on newborn and child survival in underperforming countries.

The world needs ambitious goals for interventions with the greatest potential impact on newborn and child health and development, including breastfeeding. The evidence justifies a target of 100% coverage for early initiation of breastfeeding and 80% for exclusive breastfeeding in the first six months in countries with the highest child mortality. Specific indicators tracking both of these targets are also needed so that governments and development actors are accountable for breastfeeding progress. In the absence of ambitious breastfeeding targets and indicators, the world risks continued underachievement of increasing breastfeeding rates and of maximising breastfeeding's contribution to attain global health goals.

With more ambitious targets, new strategies will be needed to drive breastfeeding rates to historically high levels, certainly since the industrial era. In this new environment, solutions will invariably come from new actors, and impact will be determined by the ability of governments, the UN, business, and civil society to work in broad partnerships based on shared value and collective impact. The ultimate goal of all parties should be to create a world where breastfeeding mothers have the freedom to breastfeed, where breastfeeding progress is unlocked through mother empowerment, and where there is a systematic breakdown of the barriers to breastfeeding through continuous innovation. This is ultimately what will make breastfeeding gains sustainable, when women everywhere can enjoy the freedom to exercise their preference for their babies to be fed breast milk.

Key points

- Breastmilk provides all of the nutrition infants needs for the first six months of life, significantly reducing the risks of sickness and death in infancy, and contributing to healthy development well into early childhood and beyond.
- Breastfeeding is one of the most under-leveraged equity strategies in child health. No other single health intervention has the potential to reduce the inequalities in health and to prevent newborn and child deaths at the scale of breastfeeding.
- Breastfeeding is a cost-effective investment in child health and development and at an estimated cost of US$175 per life saved, promotion of breastfeeding compares favourably with other nutrition intervention packages.
- There is a significant "know-do" gap in breastfeeding – women seem to be well aware of the benefits of breastfeeding but often face significant barriers, such as perceived breast milk insufficiency, pain and discomfort, transition to work, and fear of breastfeeding in public.
- To achieve an increase in breastfeeding rates, the focus of breastfeeding promotion needs to shift from isolated efforts to multi-country, multi-stakeholder partnerships.
- Current global targets for breastfeeding rates do not match the ambition of the UN Sustainable Development Goals

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