Breastfeeding and Health Outcomes for the Mother-Infant Dyad

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INTRODUCTION

“Breastfeeding saves lives” and “Breast is best!” are well-known slogans for physicians and women. Putting the newborn to the breast to nurse is now considered “normative” in the United States with 75% of women doing so.1 Unfortunately, breastfeeding as a way to continue to feed infants is not yet normative. Women do not choose to breastfeed as long nor as exclusively as recommended by health experts2 and the government,3 which may result in a missed opportunity for improving infant health and, at the same time, maternal health. The evidence for this possibility is reviewed here.

KEY POINTS

• Most US women do not meet breastfeeding recommendations; a variety of factors determine likelihood of breastfeeding initiation, duration and exclusivity, including socio-demographic and biologic variables, attitudinal characteristics, and the healthcare environment.
• Breastfeeding protects child health and development by reducing risk of infection and Sudden Infant Death Syndrome (SIDS) during infancy and by reducing risk of cancers, improving cognitive outcomes, and promoting appropriate metabolic development through childhood.
• Only one randomized trial, the Promotion of Breastfeeding Intervention Trial (PROBIT) in Belarus, has been conducted to assess the effect of breastfeeding duration and intensity on child health outcomes; results of this trial support many associations identified in epidemiologic studies.
• Breastfeeding protects the health of women by promoting postpartum weight loss and lactational amenorrhea, reducing long-term risk of reproductive cancers, and promoting the return of metabolic profiles to that of the pre-pregnant state, which may result in decreased risk of later type 2 diabetes and cardiovascular disease.

KEYWORDS

• Breastfeeding • Lactation • Postpartum weight retention • Obesity • Maternal health
• Infant health

INTRODUCTION

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This article considers some of the known determinants of the duration and exclusivity of breastfeeding and the potential confounders that may be acting at the time of breastfeeding initiation and throughout the breastfeeding period, as some of these factors, such as socioeconomic status and maternal obesity, continue to influence the infant’s later health. This article also reviews the latest evidence of relationships between breastfeeding behaviors and health outcomes for both the infant and the mother. The literature covered predominantly refers to feeding the term infant and rarely specifies the mode of feeding breast milk, whether at the breast or from a bottle. Health outcomes associated with feeding breast milk from a bottle compared to at the breast have been minimally explored to date, and are thus not a focus of this article.

DETERMINANTS OF BREASTFEEDING DURATION AND EXCLUSIVITY

Breast milk is recommended as the infant’s sole source of nutrition for the first 6 months of life. It is recommended that complementary foods be added to the infant’s diet at 6 months of age and that breastfeeding continue for one year or longer as mutually desired by mother and infant.2 Although women in the United States met the Healthy People 2010 goal for 75% of new mothers to initiate breastfeeding, the duration and exclusivity of breastfeeding remain below national goals. Determinants of breastfeeding duration and exclusivity can be grouped into five broad categories: (1) demographic variables, (2) biologic factors, (3) attitudinal characteristics, (4) hospital practices, and (5) social variables.

Demographic Factors

The demographic determinants of breastfeeding duration are the subject of a large literature and it is widely acknowledged that women who are older, better educated, and of higher income breastfeed longer.4–6 Black women are less likely to breastfeed than non-black women (Table 1).5 Degree of acculturation also has an impact on breastfeeding; every year of United States residency reduces the odds of breastfeeding to any extent by 4% and breastfeeding to 6 months by 3%.7 Duration of breastfeeding among participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) lags behind that of nonparticipants, including those who are WIC-eligible but do not participate.8 Despite WIC’s aim to promote breastfeeding, the distribution of free formula undermines the program’s message.

Biologic Factors

A negative relationship between maternal obesity postpartum and breastfeeding duration was first reported in 1992.9 Since then, the focus has been on maternal obesity at the time of conception, which is negatively associated with both the likelihood of

<table>
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<tr>
<th>Table 1</th>
<th>Breastfeeding rates by race or ethnicity</th>
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<tbody>
<tr>
<td></td>
<td>Ever Breastfed (%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>77.3</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>74.9</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>51.4</td>
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</table>

Abbreviation: BF, breastfeeding.

successful initiation of breastfeeding and its duration, though one study showed no association among black women. A recent systematic review summarized the potential reasons for the association between maternal obesity and breastfeeding as anatomic/physiologic, medical, sociocultural, and psychological (Table 2).

Maternal smoking during pregnancy is strongly negatively associated with breastfeeding duration. A dose-response effect has been shown, with the heaviest smokers having the least likelihood of establishing exclusive breastfeeding. Mothers who smoke have significantly decreased milk production compared with nonsmokers; this association may be partly related to a decreased motivation to breastfeed among smokers.

Insufficient milk supply is consistently reported as a reason for early weaning. Although up to 50% of women report that they perceive their milk supply to be insufficient, only about 5% of women suffer from a physiologically insufficient supply. In response to the perception of having an insufficient milk supply, many women supplement breastfeeding with infant formula. This reduces demand for breast milk and decreases maternal supply, compounding the problem. This biologic factor has a strong psychological component because low maternal self-efficacy for breastfeeding is associated with perceptions of insufficient milk supply.

**Attitudinal Characteristics**

High maternal self-efficacy is associated with prolonged breastfeeding. A woman’s confidence in her breastfeeding ability is positively influenced by her exposure to breastfeeding and her personal breastfeeding experience. In addition, maternal attitudes toward breastfeeding have an impact on duration. Those who perceive breastfeeding to be healthier, easier, and more convenient breastfeed longer than those who perceive that breastfeeding is restrictive, inconvenient, and uncomfortable.

It is not surprising that intended duration of breastfeeding is associated with actual duration of breastfeeding. This information is useful for clinicians because it has been suggested that “among women who intend to breastfeed, simply asking how long they plan to do so is an efficient method of identifying prenatally who is at risk for short breastfeeding duration.”

**Hospital Practices**

Hospital practices shown to improve breastfeeding duration and exclusivity include early breastfeeding initiation, infant rooming-in, and providing breast milk only. These practices are included in the “10 steps” of the Baby-Friendly Hospital Initiative (BFHI). Hospital participation in the BFHI increases rates of breastfeeding initiation,

<table>
<thead>
<tr>
<th>Potential reasons why obese women breastfeed for shorter durations</th>
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<tbody>
<tr>
<td><strong>Anatomic/physiologic</strong></td>
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<td><strong>Medical</strong></td>
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<tr>
<td><strong>Sociocultural</strong></td>
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<tr>
<td><strong>Psychological</strong></td>
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duration, and exclusivity\textsuperscript{18}; however, fewer than 5\% of babies in the United States are delivered in hospitals with BFHI certification.\textsuperscript{1}

Clinicians may also directly influence maternal breastfeeding behavior. In a prospective cohort study, researchers\textsuperscript{19} found that mothers whose pediatricians recommended formula supplementation were significantly more likely to discontinue exclusive breastfeeding by 12 weeks. Moreover, clinicians can also potentially improve women’s breastfeeding behavior by making them aware of current national or international goals for breastfeeding duration as suggested in a recent report.\textsuperscript{20}

**Social Variables**

Maternal employment negatively affects breastfeeding behavior.\textsuperscript{5} Returning to full-time work outside the home is associated with reduced duration of breastfeeding,\textsuperscript{21} whereas length of maternity leave is positively associated with duration of breastfeeding.\textsuperscript{4} Many women use breast pumps as a coping strategy for combining breastfeeding and employment.\textsuperscript{22}

The impact of professional and lay support on breastfeeding outcomes was assessed in a 2007 Cochrane meta-analysis.\textsuperscript{23} All forms of lay and professional support increased the duration of any breastfeeding.\textsuperscript{23} However, lay support and combinations of lay and professional support were more effective for continuation of exclusive breastfeeding than professional support alone.\textsuperscript{23}

Support from significant others also contributes to breastfeeding success.\textsuperscript{5,6} Breastfeeding continuation is associated with the father’s knowledge, attitude, and support,\textsuperscript{5} and also the support of the maternal grandmother.\textsuperscript{6} Fathers who receive breastfeeding information from professionals are more likely to promote and support their partner’s breastfeeding efforts.\textsuperscript{4}

It is important for clinicians to promote breastfeeding duration and exclusivity to avoid placing infants at risk of the poorer health outcomes that result from being fed infant formula as opposed to being breastfed. To optimize breastfeeding behavior, we must consider which of the determinants discussed are modifiable, when, and by whom. Attitudes, social variables, and health care practices represent a potential target for support and intervention.

**PROTECTIVE EFFECTS FOR INFANTS**

*How Breast Milk Confers Its Benefits*

Breast milk has evolved to provide the best nutrition, immune protection, and regulation of growth, development, and metabolism for the human infant.\textsuperscript{24} Breast milk is critical in compensating for developmental delays in immune function in the neonate and is responsible for reducing permeability of the intestine to prepare it for extra-uterine life.\textsuperscript{25}

The predominant antibody in breast milk, secretory IgA (sIgA), confers its immune protection by inhibiting the adherence to or penetration of the gastrointestinal (GI) tract by pathogens and by phagocytosis or cytotoxicity of pathogens.\textsuperscript{26} sIgA is higher in colostrum than mature milk, is present in a form resistant to digestion, and provides key temporal and ubiquitous immunoprotection.\textsuperscript{27,28} Additional, acquired secretory antibodies, such as IgM and IgG, depend on prior maternal exposure to pathogens and provide the infant with environment-specific immunoprotection.\textsuperscript{27}

The favorable gut microbiome that results from breastfeeding protects the infant from pathogenic bacteria and has been associated with reduced asthma and reduced obesity rates in children.\textsuperscript{29} This microbiome is a function of the interaction between
human milk’s microbiota, such as *Bifidobacteria* and *Lactobacilli*, and the oligosaccharides which serve as fuel for these bacteria; these components resist digestion and have important antimicrobial activity. The healthy microbiome promotes integrity of the intestinal barrier and competitively inhibits pathogen binding, thereby preventing inflammatory responses. Additionally, the gut microbiota contribute to regulation of the expression of genes that affect fat metabolism and deposition.

This healthy microbiome is one of many examples of the functional efficiency of breast milk because it provides immunoprotection and nutrients by synthesizing several essential micronutrients, namely vitamins B₁₂, B₆, folate, and vitamin K. Lactoferrin is another key example of functional efficiency because it aids in iron absorption, provides a significant proportion of digested amino acids, and provides immunoprotection by promoting epithelial growth and restricting bacterial access to iron. Digested milk fat globules yield monoglycerides and medium- and long-chain fatty acids with additive antimicrobial properties, and undigested milk fat globules function as vehicles for small proportions of sIgA.

Finally, breast milk contains hormones, neuropeptides, and growth factors that may affect growth, development, and self-regulation of food intake, contributing to the differences observed between breastfed and formula-fed infants. Leptin suppresses appetite and the breastfed infant’s serum leptin is positively correlated with maternal concentrations. Ghrelin, which stimulates appetite, is found in higher concentrations in foremilk than in hindmilk. This concentration difference may also contribute to the better self-regulation of intake in breastfed infants compared to formula-fed infants, and is, thus, a potential explanation for increased bottle-emptying behavior that is observed among bottle-fed infants.

**Breastfeeding and Infant Health Outcomes**

It is well-known that breastfeeding saves and improves the quality of lives even in relatively clean, industrialized contexts. In an analysis of data from the 2005 National Immunization Survey, researchers calculated that if 90% of infants were exclusively breastfed for 6 months, 911 deaths would be prevented. In an earlier analysis of the costs of formula-feeding, other investigators found that, compared with 1000 infants exclusively breastfed for 3 months, 1000 infants never breastfed required 2033 more office visits, 212 more days in the hospital, and 609 more prescriptions in the first year.

The associations between breastfeeding behaviors and infant health outcomes are the subject of a large literature that, despite limitations, establishes breastfeeding as the “gold standard” against which alternative feeds should be evaluated. Most evidence is observational because of the ethical difficulties in randomizing individuals to breastfeeding or formula-feeding. Only one large-scale experimental trial exists in a developed country: the Promotion of Breastfeeding Intervention Trial (PROBIT) in Belarus, in which hospitals were randomized to promotion of breastfeeding or standard care. As a result, the intervention and control arms of the trial comprise infants from hospitals with increased breastfeeding rates compared with infants at hospitals with baseline breastfeeding rates, and illustrate the benefits of improving breastfeeding behaviors. Because associations between breastfeeding behaviors and infant health outcomes are confounded by socioeconomic and psychosocial factors, this experimental design offers the best available evidence of causal relationships between breastfeeding and health outcomes. Moreover, among PROBIT participants, breastfeeding was nearly universal in both the intervention and control arms and illness rates were low, reducing the investigators’ power to detect a benefit of breastfeeding. Nonetheless, between-group differences were observed, and for these
outcomes a clear causal relationship can be inferred—particularly because biologic evidence supports these effects and suggests mechanisms by which these effects may occur. The evidence from PROBIT is supplemented by many systematic reviews and meta-analyses (summarized in Table 3 with associated effect measures) that, although subject to the same confounding factors, unequivocally support breastfeeding for optimal infant health.

Infections and illnesses
Infants who are not breastfed, or who are breastfed for short periods or at low intensity, have a higher risk of infection and illness than those who are breastfed optimally. In the PROBIT trial, the standard-care group experienced more GI tract infections than the intervention group. These between-group differences were clear despite diminished power, as described above.39 In the United States, where daycare is widespread and infection rates are higher than in Belarus,40 a greater effect would be expected. These findings are supported in the observational studies reviewed recently,41,42 with breastfed infants 64% less likely to contract a GI infection. PROBIT investigators were unable to confirm a similar protective effect of breastfeeding against respiratory ailments and otitis media with experimental data, but the unexpectedly high breastfeeding rates and low incidence of these infections may not have allowed adequate power to do so.39 In their recent meta-analysis of studies from 1980 to 2001, Bachrach and colleagues43 found that breastfed infants had a 72% lower risk of hospitalization for respiratory infections. In addition, investigators of a subsequent prospective cohort in the Netherlands found evidence to support a protective role for breastfeeding against GI and upper- and lower-respiratory tract infections. In the Netherlands cohort, only infants who were breastfed for at least 6 months had lower risk for GI and respiratory-tract infections than controls who were not breastfed.44 Moreover, the protective effects of breastfeeding persisted after cessation, although they diminished over time.41,42

In addition to sufficient breastfeeding duration, it is important to provide breast milk exclusively to reduce the risk of infection and illness because this behavior reduces the infant’s exposure to illness-causing agents. Among PROBIT infants who were exclusively breastfed for at least 3 months, those who continued to be exclusively...
Breastfed were one-third less likely to have 1 or more GI infections in the first year than infants who were partially breastfed thereafter. In a recent meta-analysis of cohorts from 1989 to 1997, the investigators found that although infants ever breastfed were three-quarters as likely to contract otitis media than those never breastfed, infants exclusively breastfed for at least 3 months were half as likely. In a subsequent prospective cohort, infants exclusively breastfed for 4 months were at greater risk of contracting an upper-respiratory tract infection than those exclusively breastfed for a full 6 months.

**Neurologic outcomes**

Breastfed and formula-fed babies differ in neurologic outcomes, but this association is confounded by socioeconomic status, parental education, parental intelligence, and the home environment. The experimental design of the PROBIT provides strong evidence of an effect independent of these confounders; at 6.5 years follow-up, children who were in the intervention arm had higher IQ scores and teacher ratings than those in the control arm. Although Der and colleagues did not find support for the association between breastfeeding and cognitive outcomes in their recent prospective cohort and meta-analysis of prior studies through 2004, their sibling analysis in the cohort and the observational design of studies included in the meta-analysis may not have sufficiently controlled for confounding.

**Sudden infant death syndrome**

Although sudden infant death syndrome (SIDS) deaths have declined substantially in 20 years, PROBIT was not statistically powered to detect differences in mortality, yet investigators found a nonsignificant trend in reduction of SIDS risk in the intervention group ($P = .12$). The American Academy of Pediatrics (AAP) recommends breastfeeding to further reduce SIDS risk because, although this association is not well-understood, it has been recently shown to be independent of infant sleeping position. In two recent meta-analyses, the investigators found a protective effect of ever breastfeeding.

**Asthma and atopic allergies**

Although it is commonly thought that breastfeeding behavior is associated with risk of asthma and allergies, there was no difference in allergy risk between PROBIT groups. Meta-analyses and reviews of observational evidence have been unable to clarify this association because of lack of power, inconsistent diagnostic criteria, and unresolved confounding. Meta-analyses have found protective effects of breastfeeding, particularly when family history for allergic rhinitis, atopic allergies, and asthma was present. However, there is some evidence from cohort studies that breastfed infants have increased risk of asthma and similar or increased risk of allergy.

**Pediatric cancers**

Despite a large literature, including recent meta-analyses, evidence linking breastfeeding and risk of childhood cancers is limited. This results from limited exploration of
## Table 3
Evidence supporting protective effects of breastfeeding on infant health

<table>
<thead>
<tr>
<th>Health Outcome</th>
<th>Strongest Evidence</th>
<th>Source</th>
<th>Comparison Groups</th>
<th>Odds ratio&lt;sup&gt;a&lt;/sup&gt;</th>
<th>(Amount)-Fold Risk&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI tract infection (0–12 mo)</td>
<td>Experimental (hospital BF promotion vs standard care)</td>
<td>Kramer et al.,&lt;sup&gt;39&lt;/sup&gt; 2001</td>
<td>Intervention vs control (baseline breastfeeding vs increased breastfeeding)</td>
<td>0.6</td>
<td>1.67</td>
</tr>
<tr>
<td>GI tract infection (3–6 mo)</td>
<td>Experimental (hospital BF promotion vs standard care)</td>
<td>Kramer et al.,&lt;sup&gt;45&lt;/sup&gt; 2003</td>
<td>Exclusively BF at 3 mo and partially BF ≥6 mo vs exclusively BF ≥6 mo</td>
<td>0.35</td>
<td>2.86</td>
</tr>
<tr>
<td></td>
<td>Meta-analysis of cohorts</td>
<td>Chien et al.,&lt;sup&gt;42&lt;/sup&gt; 2001</td>
<td>Ever-BF vs never-BF</td>
<td>0.36</td>
<td>2.78</td>
</tr>
<tr>
<td>Respiratory infection</td>
<td>Cohort</td>
<td>Duijts et al.,&lt;sup&gt;44&lt;/sup&gt; 2010</td>
<td>Exclusively BF at 4 mo and partially BF thereafter vs never-BF</td>
<td>URTI: 0.65</td>
<td>LRTI: 1.54</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Exclusively BF ≥6 mo vs never-BF</td>
<td>LRTI: 0.50</td>
<td>URTI: 2.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>URTI: 0.37</td>
<td>LRTI: 2.70</td>
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<td></td>
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<td></td>
<td></td>
<td>LRTI: 0.33</td>
<td>LRTI: 3.03</td>
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<tr>
<td>Hospitalization for respiratory infection</td>
<td>Meta-analysis</td>
<td>Bachrach et al.,&lt;sup&gt;43&lt;/sup&gt; 2003</td>
<td>Ever-BF vs never-BF</td>
<td>0.26</td>
<td>3.85</td>
</tr>
<tr>
<td>Otitis Media</td>
<td>Meta-analysis of cohorts</td>
<td>Ip et al.,&lt;sup&gt;41&lt;/sup&gt; 2009</td>
<td>Ever-BF vs never-BF</td>
<td>0.77</td>
<td>1.30</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Exclusively BF ≥3 mo vs never-BF</td>
<td>0.5</td>
<td>2.00</td>
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<tr>
<td>Cognitive Development</td>
<td>Experimental (hospital BF promotion vs standard care)</td>
<td>Kramer et al, 2008</td>
<td>Intervention vs control (ie, baseline breastfeeding vs increased breastfeeding)</td>
<td>+5.9 points on full-scale IQ</td>
<td>N/A</td>
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<tr>
<td>Sudden Infant</td>
<td>Meta-analysis</td>
<td>Hauck et al, 2011</td>
<td>Ever-BF vs never-BF</td>
<td>0.55</td>
<td>1.82</td>
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<tr>
<td>Death Syndrome</td>
<td></td>
<td></td>
<td>BF ≥2 mo vs never-BF</td>
<td>0.38</td>
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<td></td>
<td>Exclusively BF any duration vs never-BF</td>
<td>0.27</td>
<td>3.70</td>
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<tr>
<td>Acute Lymphoblastic</td>
<td>Meta-analysis</td>
<td>Ip et al, 2009</td>
<td>BF &gt;6 mo vs never-BF</td>
<td>0.81</td>
<td>1.23</td>
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<tr>
<td>Leukemia</td>
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<td></td>
<td></td>
<td>Arenz et al, 2004</td>
<td>Ever-BF vs never-BF</td>
<td>0.79</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>Meta-analysis</td>
<td>Owen et al, 2005</td>
<td>Ever-BF vs never-BF</td>
<td>0.87</td>
<td>1.15</td>
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<tr>
<td></td>
<td></td>
<td>Harder et al, 2005</td>
<td>BF duration 1–3 mo vs never-BF</td>
<td>0.81</td>
<td>1.23</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>BF duration 4–6 mo vs never-BF</td>
<td>0.76</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>BF duration 7–9 mo vs never-BF</td>
<td>0.67</td>
<td>1.49</td>
</tr>
</tbody>
</table>

**Abbreviations:** BF, breastfed; LRTI, lower respiratory tract infection; URTI, upper respiratory tract infection.

*Odds ratios reported by original investigators, in which the less-ideal behavior (the second comparison group listed) is used as the referent. The OR thus represents the benefit conferred by breastfeeding.*

*Amount-fold-risk as recalculated by the authors, in which the more-ideal breastfeeding behavior (the first comparison group listed) is used as the referent, reflecting the authors’ suggestion that breastfeeding be considered the normative standard. The (amount)-fold-risk represents the increase in morbidity and mortality associated with formula-feeding.*
certain cancers, small sample sizes, reliance on long-term recall, conflicting or null results, and between-study design heterogeneity. However, there is some evidence that breastfeeding may reduce risk of acute lymphoblastic leukemia, and duration of breastfeeding may be important. Studies have reported that infants breastfed greater than 6 months had a 24%\(^{58}\) and 19%\(^{41}\) reduction in risk of acute lymphoblastic leukemia compared with those not breastfed, whereas those breastfed less than or equal to 6 months had a 12% reduction.\(^{58}\)

**Childhood obesity**

The two major mechanisms by which breastfeeding may protect against obesity in the child are through the components or composition of human milk and behaviors related to infant feeding (Fig. 1). In addition to the effects of breast milk components and the microbiome described above, its lower protein concentration may help to protect the infant against later adiposity.\(^{59}\) Behaviors of the caregiver may also contribute to the higher obesity rates observed among formula-fed than breastfed infants. Caregivers who encourage bottle-fed infants to empty the bottle may override the infants’ internal satiety cues, which may result in poor infant self-regulation of intake. A study by Li and colleagues\(^{36}\) supports this notion because infants fed more often from a bottle (vs at the breast) were more likely to finish a bottle at a feeding.

The association between breastfeeding and obesity is controversial. Data from the 6.5-year follow-up of PROBIT provide the only experimental evidence with which to determine whether or not formula-feeding instead of breastfeeding increases the risk of childhood obesity.\(^{60}\) No differences were observed between the intervention and standard-care groups in overweight or obesity. It is possible that the difference between some breastfeeding in the control versus more breastfeeding in the intervention groups was not large enough to observe an effect on child obesity because most mothers in both groups initiated and were still breastfeeding at 3 months postpartum. Additionally, the investigators advise caution when generalizing these findings to contexts in which the obesity epidemic is rampant because the proportions of children in PROBIT who were greater than or equal to the 85th (13%) or the 95th (5%) percentiles for BMI were substantially lower than those in the United States (33% and 18%, respectively).\(^{61}\)

In meta-analyses of observational studies of breastfeeding and the risk of childhood obesity there were small, yet consistent, reductions in obesity risk of 13%\(^{62}\) and 22%\(^{63}\) for breastfed compared with formula-fed infants. In another meta-analysis,\(^{64}\) a dose-response relationship was identified; there was a 4% reduction in obesity risk for each month of breastfeeding. In contrast, mean body mass index (BMI) was only minimally lower among breastfed compared with formula-fed individuals in a quantitative review of published and unpublished studies, which the investigators attributed to confounding factors.\(^{65}\)

The importance of breastfeeding for growth may depend on the child’s existing adiposity. In one recent study, it seemed that breastfeeding resulted in a healthier BMI distribution overall\(^{66}\) as fewer children were either underweight or obese.

Infants born to obese mothers are at high risk of developing obesity for several reasons. These infants may have inherited a genetic predisposition to obesity, are exposed to an obesogenic environment in utero, are likely to be breastfed for a shorter period than infants of normal-weight mothers, and may be exposed to an obesogenic family food environment. Infants of heavier Danish mothers who were breastfed for longer periods gained 11% less in their first year of life than those who were breastfed for shorter periods.\(^{67}\) In a study of US infants, Li and colleagues\(^{68}\) found that children of obese mothers who never breastfed had a sixfold higher odds of becoming
Fig. 1. Possible mechanisms, beneficial effects (+) and detrimental effect (−), through which breastfeeding promotes healthy infant weight status. Caregiver behaviors and the contents of human milk have effects on the breastfed infant’s self-regulation of intake, growth and metabolism, and the intestinal microbiome, which, in turn, promote development of healthy weight. HMO, human milk oligosaccharides.
overweight compared with children of normal-weight mothers that breastfed for at least 4 months. Based on this evidence, mothers who are obese and children of obese mothers are a key group to target for breastfeeding assistance, and effective interventions are needed to help this population.  

**Cardiovascular and metabolic disease risk**

Effects of breastfeeding on risk factors for cardiovascular and other metabolic diseases have also been examined in observational studies. In a meta-analysis of seven studies, breastfeeding decreased the risk of type 2 diabetes by nearly 40% compared with formula-feeding. Fasting insulin values in later life were 3% lower among those who were breastfed, indicating an association with improved insulin-sensitivity. Breastfeeding may also decrease later risk of type 1 diabetes and blood pressure in adulthood, although evidence for these outcomes are less conclusive because of potential problems of confounding and publication bias.

**MATERNAL HEALTH OUTCOMES OF BREASTFEEDING**

The advantages of breastfeeding for mothers are not as well studied as those for infants, but there is adequate evidence to state that women who breastfeed are likely to have improved health in the short-term, and are at lower risk of developing future diseases (Box 2).

**Immediate and Early Benefits to the Mother**

**Postpartum weight loss**

Childbearing is associated with long-term weight gain, and postpartum weight retention has been associated with adverse outcomes in later pregnancies.

<table>
<thead>
<tr>
<th>Box 2</th>
<th>Maternal benefits of breastfeeding</th>
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<tbody>
<tr>
<td><strong>Breastfeeding may confer immediate and long-term benefits to mothers, especially if recommendations for exclusivity and duration are met. Such benefits may strengthen motivation or commitment to breastfeeding</strong></td>
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<tr>
<td>• Reasons to initiate breastfeeding</td>
<td></td>
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<tr>
<td>- Reduce maternal bleeding after delivery</td>
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<tr>
<td>- Involute uterus</td>
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<tr>
<td>- Facilitate positive metabolic changes</td>
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<tr>
<td>- Facilitate postpartum weight loss</td>
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<tr>
<td>- Reduce stress</td>
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<td>- Delay ovulation</td>
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<tr>
<td>• Reasons to continue breastfeeding</td>
<td></td>
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<tr>
<td>- Increase postpartum weight loss</td>
<td></td>
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<tr>
<td>- Prolong lactational amenorrhea</td>
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<td>- Decrease visceral adiposity</td>
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<tr>
<td>- Reduce type 2 diabetes risk</td>
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<td>- Reduce cardiovascular risk</td>
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<td>- Reduce breast cancer risk</td>
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<td>- Reduce ovarian cancer risk</td>
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Dieterich et al
Breastfeeding, conversely, is associated with postpartum weight loss.\textsuperscript{75,76} In a large prospective cohort study, Baker and colleagues\textsuperscript{76} showed that greater intensity (exclusivity) and duration of breastfeeding was associated with greater weight loss at 6 and 18 months postpartum in women of all BMI categories. This is not surprising since exclusive breastfeeding has a maternal energy cost of about 500 kcal per day. However, it must not be overlooked that increases in maternal caloric intake or decreases in physical activity can attenuate the weight loss effects of lactation.\textsuperscript{77}

**Bonding**

Breastfeeding is often mentioned as a facilitator of mother-infant bonding\textsuperscript{78} and bonding is reported by women as a reason for breastfeeding.\textsuperscript{79} Although potential hormonal and social mechanisms exist that may promote bonding, a systematic review by Jansen and colleagues\textsuperscript{80} found that the empirical evidence is limited. Subsequently, evidence for a biologic link between breastfeeding and bonding is emerging. Higher brain responses to their own infants’ cry and more sensitive behavior were exhibited by breastfeeding mothers than by formula-feeding mothers.\textsuperscript{81}

**Lactational amenorrhea**

Breastfeeding exclusively has the natural effect of suppressing ovulation, thereby acting as a natural birth control for up to 6 months (or as long as the woman is exclusively breastfeeding and her menses have not returned).\textsuperscript{72} Lactation must be used with caution for family planning among women who do not breastfeed exclusively or only do so for a brief period.

**Long-Term Maternal Benefits of Breastfeeding**

**Diabetes, metabolic, and cardiovascular risk**

Pregnancy is associated with changes in glucose and lipid metabolism that support the growing fetus; however, these changes can be deleterious to the mother’s health. Breastfeeding, on the other hand, is associated with favorable metabolic changes. The “Reset Hypothesis”\textsuperscript{77} proposes that the favorable metabolic changes in lactation persist after weaning, resulting in the observed long-term decreases in chronic disease risk among women who have breastfed. All of the current evidence for this comes from observational studies, so confounding and selection bias cannot be ruled out.

Pregnancy is an insulin-resistant state, which results from the effects on the mother of placental hormones with anti-insulin effects. These metabolic changes can cause gestational diabetes, and may increase the risk of type 2 diabetes later in life. Conversely, during lactation, insulin-sensitivity improves and may have lasting effects\textsuperscript{77} because a 4% to 12% reduction in the risk of type 2 diabetes was observed for every 12 months of lifetime lactation.\textsuperscript{82} Breastfeeding intensity may also be also important because a 50% higher risk of developing type 2 diabetes was observed among women who never exclusively breastfed compared with those who exclusively breastfed for 1 to 3 months.\textsuperscript{83}

Pregnancy is also a hyperlipidemic state, with increased concentrations of blood cholesterol and triglycerides; conversely, lactation promotes favorable effects on maternal blood lipids.\textsuperscript{77} Research has found that lactation is associated with lower risk of longer-term metabolic risk factors and cardiovascular disease.\textsuperscript{84,85} Women who breastfed their children have been less likely to have developed hypertension, diabetes, hyperlipidemia, and cardiovascular disease when controlling for multiple important socio-demographic and lifestyle variables.\textsuperscript{84} Conversely, some studies have found no association of breastfeeding and disease risk.\textsuperscript{86} A systematic review is warranted to assess the totality of this growing literature.
Reproductive cancers
A decrease in risk for reproductive cancers has been observed among women who have breastfed, possibly due to their reduced lifetime exposure to hormones such as estrogen. According to a 2002 meta-analysis, women with breast cancer were less likely to have breastfed, and they had a shorter average lifetime duration of breastfeeding than did women who had not developed this disease. Furthermore, the risk of breast cancer decreased by 4.3% for each year of breastfeeding, which indicates that longer breastfeeding duration may increase protection against breast cancer. In another meta-analysis, there was a 28% lower risk of developing ovarian cancer among women who breastfed for at least 12 months compared with women who never breastfed.

Together, the evidence of effects of breastfeeding on maternal health suggest that breastfeeding protects the mother from many short- and long-term health problems, and that breastfeeding exclusively and for longer durations results in the most optimal maternal health.

SUMMARY
As this overview makes clear, there is persuasive evidence available to support recommendations by the health authorities and to support national goals for breastfeeding duration. These recommendations and goals treat breastfeeding as the optimal way to feed infants during their first year of life, along with the timely addition of complementary foods. Moreover, there is a growing body of evidence that supports breastfeeding as a way to improve a woman’s health after pregnancy because it may help her to return to a normal metabolic profile and to lose the weight she gained during pregnancy—among other benefits. Indeed “breast is best!” for mothers as well as their babies.

REFERENCES


