

Human Milk and Breastfeeding: Research Update 2026

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I have no conflicts of interest to declare



Core Session Objectives

- Explore the value of breastfeeding and human milk
- Consider current research and practical applications for supporting breastfeeding

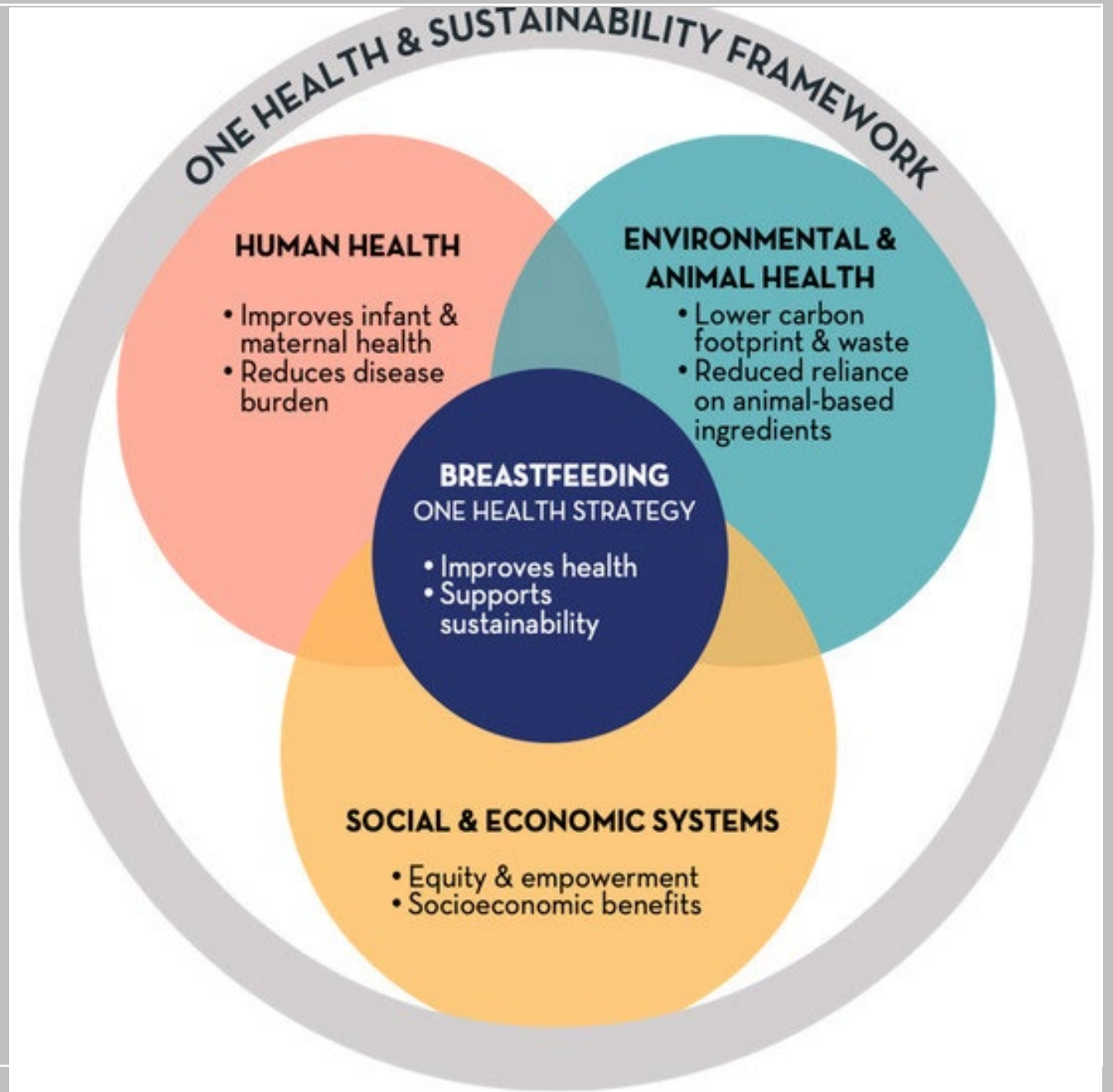
Key Findings

- **Human milk is an active, living fluid explicitly designed to nurture the immature infant immune system.**
- Prioritizes gut maturation, creating a protective structural barrier against foreign pathogens.
- Functions as a dynamic vehicle for continuous immunomodulation and baseline physiological programming.
- Breastfeeding establishes an indispensable foundation for lifelong metabolic and immune health.

Integrating breastfeeding into One Health and sustainability frameworks strengthens resilience, equity and planetary health

Vieira Borba V, et al. Breastfeeding as a Strategic Driver for One Health: A Narrative Review. 2025.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC12694379/>



Benefits that may last beyond infancy

EVIDENCE BRIEF

What **a 2025 study** of 9–10-year-olds adds

Breastfeeding duration was associated with brain–body development at ages 9–10, and socioeconomic levels changed that relationship.

Rajagopalan, V., Hsu, E. & Luo, S. Breastfeeding duration and brain-body development in 9–10-year-olds: modulating effect of socioeconomic levels. *Pediatr Res* **97**, 378–386 (2025).
<https://doi.org/10.1038/s41390-024-03330> <https://rdcu.be/mj8zzgjau2Pa>

SOCIOECONOMIC MODULATION: The association did not look identical across socioeconomic levels. **Context changed the strength of the relationship.**

01 Time and job flexibility

Feeding duration is shaped by work, leave, and daily constraints.

02 Access to skilled support

Early challenges are easier to address when help is available.

03 Resources and cumulative stress

Social conditions can influence both feeding and later development.

Rajagopalan, Hsu & Luo · Pediatric Research 97 (2025)

Complex Pathways

01

**Nutrition +
bioactive factors**

Human milk provides nutrients and signaling components during rapid early development.

02

**Immune +
metabolic
programming**

Early feeding may interact with immune maturation and longer-term metabolism.

03

**Caregiving +
social context**

Feeding experiences occur within attachment, healthcare, work, income, and support systems.

Rajagopalan, Hsu & Luo · Pediatric Research 97 (2025)

The practical benefit grows when families are supported

01

Protect time

Paid leave, flexible work, and private feeding or pumping space.

02

Make skilled help easy

Early, culturally safe lactation support without cost barriers.

03

Respect informed choice

Support breastfeeding where desired—and safe alternatives without stigma.

Equity is not an add-on; it is part of the developmental pathway.

Benefits for Children

- **Microbiome Preservation & Chronic Disease Prevention:** Longitudinal findings from [Canada's CHILD Cohort Study](#) demonstrated that **breastfeeding acts as a vital buffer that protects the child's gut microbiota** well into early childhood. This microbial stability directly correlated to a reduced risk of developing **asthma, obesity, and behavioural challenges** by age five, helping to bridge health disparities in lower-income families. [1]
- **Proven Causal Protection Against Asthma:** A **2025** Mendelian Randomization study published in *PMC* explored genetic causal pathways of breastfeeding. While it noted that observational cognitive benefits can sometimes be heavily confounded by socioeconomic factors, it established a **definitive, genetically supported causal protective effect against childhood asthma**. [1]
- **Neurodevelopmental and Immune Support:** A comprehensive **2024** analysis published in *Nutrients* emphasized that **bioactive components like sialic acid and docosahexaenoic acid (DHA) in breast milk are vital for structural brain development**. Additionally, natural sleep regulators in milk (like tryptophan and melatonin) were shown to improve **infant sleep cycles** while reinforcing **immune defenses** against common acute pediatric infections. [1]

Gene Expression Changes in the Child

- **The Largest Global Epigenetic Mapping (2026):** A landmark international study published in *Clinical Epigenetics* tracked nearly 3,500 children across 11 countries. Led by the [Barcelona Institute for Global Health \(ISGlobal\)](#), researchers discovered that infants exclusively breastfed for at least three months carried distinct **DNA methylation marks** in their blood that lasted years into childhood. These altered "chemical tags" directly **regulate genes associated with immune system maturation and structural development**. [[1](#), [2](#), [3](#), [4](#)]
- **Obesity Pathway Regulation (2024):** A study focusing on the interaction of genetic risks and early-life nutrition found that **breastfeeding directly counterbalances genetic predispositions to metabolic disorders**. It achieves this by down-regulating the expression of the **FTO (obesity-associated) gene** and the **CPT1A gene** in infants while significantly increasing the expression of the **PPAR-α gene**, which acts as a **master regulator of fatty acid oxidation**. [[1](#), [2](#)]
- **Gut Splicing and Polyamine Impact (2025):** Clinical profiling published in *Clinical Nutrition* examined the impact of bioactive components (polyamines like spermidine) in mature breast milk. Microarray analyses of infants' exfoliated gut cells revealed that **higher concentrations altered 15 distinct genes, notably up-regulating TNFAIP6 and interleukin-8, permanently modifying early-life immune defense localized in the gut**. [[1](#)]

Benefits for Mothers

- **Long-Term Mental Health Protection:** breastfeeding is linked to a reduced risk of long-term depression and anxiety. The study revealed a dose-response effect—meaning that a longer duration of breastfeeding (or breastfeeding across multiple pregnancies) offered stronger, enduring psychological protection even 10 years postpartum.
- **Enhanced Mother-Infant Interactions:** A 2024 cohort study evaluating maternal sensitivity found that exclusive breastfeeding at 3 months postpartum significantly enhanced positive mother-infant interactions. Mothers who continued breastfeeding up to 6 months reported fewer symptoms of anxiety and antenatal depression, displaying higher levels of maternal cooperation.
- **Decade-Long Weight Management:** A large-scale 2026 epidemiological study from the University of Oslo tracking over 170,000 women found that breastfeeding for 3 to 15 months per child correlates to significantly lower weight gain from young adulthood to middle age. This protective metabolic reset was most pronounced in mothers who had overweight or obesity prior to pregnancy.

Gene Expression Changes in the Mother

- **Oxytocin Receptor Modification (2025):** A pioneering study titled *Maternal Depression, Epigenetics and Breastfeeding* demonstrated that specific chemical modifications to the **oxytocin receptor gene** dictate clinical outcomes. Women who presented with specific epigenetic variations on this gene were biologically primed to seamlessly maintain breastfeeding through 6 months due to enhanced milk-release signaling and neurological bonding pathways
- **Mammary Gland "Imprinted" Control System (2024):** Genomic profiling from the University of Cambridge identified a tightly controlled system of **25 imprinted genes** that activate at precise intervals during the postpartum cycle. These genes, which are selectively switched on or off depending on parental inheritance, orchestrate the severe cellular remodeling of the adult mammary gland and protect against long-term oncogenic tissue mutations.

Maternal mental health: benefits and an important caveat

Evidence suggests an association between positive breastfeeding experiences and maternal mental health outcomes.

Potential benefit

A 2022 systematic review included 55 studies; 29 of 36 studies reporting significant relationships found breastfeeding associated with fewer depression/anxiety symptoms.

Support matters

The review also found that breastfeeding challenges were associated with higher risk of negative mental-health symptoms.

Do not overstate causality

The 2025 Cochrane review found low-certainty evidence that psychosocial breastfeeding interventions may prevent postpartum depression short-term; evidence for other mental-health outcomes was very uncertain.

Clinical approach: protect both feeding goals and mental health

- Ask about mood, anxiety, sleep, pain, feeding confidence, and whether the feeding plan feels sustainable.
- Normalize help-seeking: breastfeeding difficulties are common and deserve skilled, timely support.
- Screen and respond to postpartum depression/anxiety according to local clinical pathways; do not use breastfeeding status as a proxy for mental health.
- Frame breastfeeding as one possible contributor to well-being—not as a treatment for depression or anxiety.
- If breastfeeding is worsening distress, work collaboratively on alternatives, including combination feeding or formula, while maintaining infant feeding and maternal well-being goals.

Clinical implications: what health workers can do

- Communicate benefits accurately: use 'associated with' when discussing observational evidence.
- Support breastfeeding without turning duration or exclusivity into a pass/fail target.
- Assess practical barriers—pain, latch problems, milk transfer, feeding frequency, pumping demands, and family/work context.
- Use skilled lactation support early when difficulties arise.
- Keep the infant's growth, hydration, feeding effectiveness, and developmental surveillance central to care.

Key message

Support breastfeeding without sacrificing maternal mental health.

- The evidence supports important infant-health benefits and suggests potential maternal mental-health benefits associated with positive breastfeeding experiences.
- At the same time, breastfeeding challenges can be psychologically harmful, and current intervention evidence does not establish breastfeeding as a proven preventive treatment for postpartum depression.
- The clinical priority is individualized, compassionate support that protects both infant health and the mother's physical and mental well-being.

Additional Maternal Mental-Health References:

Yuen M, et al. The Effects of Breastfeeding on Maternal Mental Health: A Systematic Review. Journal of Women's Health. 2022;31(6):787–806.

Systematic review of 55 studies; breastfeeding generally associated with better maternal mental-health outcomes, while challenges/expectation discordance could be associated with worse outcomes.

Lenells M, et al. Breastfeeding interventions for preventing postpartum depression. Cochrane Database of Systematic Reviews. 2025;2:CD014833.

10 studies, 1,573 participants. Low-certainty evidence that psychosocial breastfeeding interventions may prevent postpartum depression short-term; evidence for most other outcomes was very uncertain.

Zamani M, et al. Breastfeeding in Women with Postpartum Depression: A Systematic Review and Meta-Analysis. Ethiopian Journal of Health Sciences. 2025;35(4):302–311.

Nine studies; postpartum depressive symptoms were associated with higher odds of nonexclusive breastfeeding, highlighting the bidirectional relationship.

Antenatal Milk Expression:

AME improved prenatal breastfeeding self-efficacy in women with GDM, was associated with earlier lactogenesis onset and a lower incidence of delayed onset of lactogenesis II and increased early in-hospital exclusive breastfeeding rates.

Cai F, Jia Z, Wu Y, Zeng M, Wang Z, Yang J, Xu M, Zhang Y. Effect of antenatal milk expression on prenatal breastfeeding self-efficacy, lactogenesis onset, and early exclusive breastfeeding in pregnant women with gestational diabetes mellitus: a randomized controlled trial. [Int Breastfeed J. 2026](#) Aug 6;21(1):81. doi: 10.1186/s13006-026-00879-w. PMID: 42681636; PMCID: PMC13531841.

Metformin : A support role for lactation ?

Journal of Food & Nutritional Sciences [2025; 6(1): 30-54]

Safe for use during breastfeeding

Mammary gland is sensitive to insulin during pregnancy and lactation

Metformin improves insulin sensitivity

Small studies so far but positive results in the first 4-6 weeks post partum

(Canadian physicians were more likely to prescribe metformin, levothyroxine, and domperidone as well as herbal galactagogues for low milk supply)

September 2024 in *Cancer Medicine*:

A research team has been assessing HAMLETs (Human Alpha-lactalbumin Made LEthal to Tumor cells) potential as a cancer treatment by entering the nuclei of cancer cells and reprogramming their DNA, blocking essential functions.

The cancer cells die in a way that spares the surrounding healthy tissue.

A drug developed from hamlet reduced the size of 88% of tumours in bladder- cancer patients with no side-effects, other than discomfort at the injection site.

Haq F, Sabari S, Háček J, et al. *Clinical and molecular response to alpha1-oleate treatment in patients with bladder cancer. Cancer Med.* 2024; 13:e70149. doi:[10.1002/cam4.70149](https://doi.org/10.1002/cam4.70149).
<https://doi.org/10.1002/cam4.70149>Digital Object Identifier (DOI).
<https://onlinelibrary.wiley.com/doi/full/10.1002/cam4.70149>

Intranasal breast milk as a preventive treatment for brain haemorrhage in premature babies

Putra HH, Luthfi M, Abdurrahman R, et al. Clinical Outcomes of Intranasal Breast Milk Administration in Preterm Infants: A Systematic Review. *Journal of Neonatology*. 2026;0(0).
doi:[10.1177/09732179261467112](https://doi.org/10.1177/09732179261467112)

Premature babies with brain injury: The babies subsequently had less brain damage, and required less surgery, than those who did not receive the treatment.

Hospital for Sick Children in Toronto: administered intranasal breast milk as a preventive treatment for brain haemorrhage in premature babies; 18 months later, babies so treated had better motor and cognitive development, and fewer vision problems, than those fed only the usual way.

Live Clinical Trial: Infant Brain Hemorrhage Pilot (2024–2026)

- **Study Title:** *Outcomes After Intranasal Human Milk Therapy in Preterm Infants with Intraventricular Hemorrhage* [1]
- **Publication & Source:** Managed by [ClinicalTrials.gov \(NCT04225286\)](https://clinicaltrials.gov/ct2/show/study/NCT04225286) and analyzed through the [University of Toronto](#). [1, 2]
- **Methodology:** Preterm infants (<33 weeks gestation) diagnosed with any grade of IVH or intraparenchymal hemorrhage were given escalating daily doses of fresh, maternal breast milk intranasally up to 28 days of age. [1, 2]
- **Key Findings:** Long-term follow-ups at 4–12 and 18 months corrected age demonstrated that **neurological and neurodevelopmental outcomes favoured the intranasal milk therapy group** compared to historical controls. **It successfully verified that fresh human milk can safely act as a non-invasive stem cell delivery mechanism.** [1]

The potential of human milk oligosaccharides (HMOs) in ameliorating traumatic brain injury



- HMOs significantly ameliorate traumatic brain injury (TBI)-induced cognitive impairment in mice.
- HMOs exert neuroprotective effects through a multi-target mechanism: inhibiting oxidative stress and proinflammatory cytokines in the hippocampus to alleviate neuronal damage, while mitigating intestinal barrier injury by restoring occludin expression and reducing colonic IL-6.
- HMOs support hippocampal synaptic function by reversing TBI-induced dysregulation of key synaptic proteins, offering a promising natural therapeutic strategy for TBI.

He, D., He, R., Duan, W., Li, G., & Kang, Q. (2026).

<https://doi.org/10.1080/20565623.2026.2622241>

Support the opportunity. Respect the choice.

The most responsible pathway is practical, equitable support paired with humility about causation and individual outcomes.

Rajagopalan, V., Hsu, E. & Luo, S. Pediatric Research 97, 378–386 (2025).doi.org/10.1038/s41390-024-03330-0