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Review Article

A Comprehensive Review of Maternal Nutrition with Emphasis on the Nutritional Requirements of Lactating Women

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Abstract

Breastfeeding periods are more nutrient-demanding than non-pregnant and non-lactating states. This review aims to examine, compare, and summarize the scientific data on the nutritional requirements of lactating mothers. Producing one liter of breast milk requires approximately 700 kcal of energy, making lactation a physiologically demanding process. Diets low in total energy or fat can mobilize of maternal fat stores, potentially leading to weight loss. Nursing mothers who consume more than 1 g/kg of protein per day can preserve their lean body mass. According to the U.S. and Canadian Recommended Dietary Allowances (RDA), the recommended carbohydrate intake for breastfeeding mothers is 210 g/day. Because maternal micronutrient status affects pregnancy outcomes, infant growth and development, and maternal health, it should be addressed from preconception through lactation. Due to maternal homeostatic mechanisms, many mineral levels do not fluctuate significantly during lactation, as absorption, excretion, and mobilization from body stores such as bone help maintain adequate mineral concentrations in breast milk and maternal circulation. In contrast, vitamin requirements increase significantly to support maternal health and infant growth. Lactating women require higher amounts of vitamins A, B12, C, and D than non-lactating women, as these vitamins and minerals are actively transferred into breast milk to support infant growth, immune function, and overall development. Maternal nutrition is therefore crucial for both mother and child. Increasing dietary intake during lactation is essential, and future research should evaluate culturally appropriate nutrition interventions, supplementation strategies, and food-based programs to improve maternal nutrient intake. Policy measures could include developing national maternal nutrition guidelines, promoting community-based education on dietary diversity, ensuring access to fortified foods or supplements, and integrating maternal nutrition support into existing healthcare and public health programs.

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INTRODUCTION

Breastfeeding periods are more nutrient-demanding than non-pregnant and non-lactating periods (FAO/WHO, 2015; Moran *et al*., 2014; Eggert and Eggert *et al*., 2015). The health and welfare of both mothers and their children depend on the nutritional status of the mother during pregnancy and nursing (WHO, 2013). Factors such as the length and intensity of lactation, as well as the recovery period, have an impact on maternal nutrition (Moran *et al*., 2010; Ahmed *et al*., 2014). Furthermore, Sociocultural and economic limitations should be considered when evaluating the dietary needs of nursing mothers, as lactation is a crucial relational function between the mother and child (Ikpeama *et al*., 2024). To provide a varied and well-balanced diet, nursing mothers should eat a range of nutrient-dense foods (Beal *et al*., 2024).

In low-income nations, maternal nutrition is a significant public health issue, especially in Africa, South Asia, Latin America, and the Caribbean, where 10–20% of women suffer from malnutrition (Hasan *et al*., 2022). In these nations, moms who are severely malnourished produce less breast milk (Ahmed *et al*., 2022). According to evidence from earlier studies, some nursing moms may still produce the best milk for their babies even if they do not increase their energy intake throughout the lactation period (Waldby *et al*., 2023). This is due to breast milk is produced by nursing mothers using their body fat, protein, and minerals (Sánchez *et al*., 2021). Agricultural practices, poor nutritional diets, frequent infections, inadequate food intake, and short inter-pregnancy intervals brought on by a lack of education, a lower socioeconomic status, ethnic and cultural beliefs, and national policies are the most common causes of maternal malnutrition in developing nations (Shenoy et al., 2023).

Many socioeconomic variables exacerbate Ethiopia's high rate of breastfeeding mother malnutrition (CSA, 2006). Socioeconomic factors have been linked to the prevalence of underweight and low nutritional intake in Ethiopia (Alemayehu *et al*., 2015; Moges *et al*., 2018; Kejela *et al*., 2019). Haileslassie *et al*. (2013) reported that in southern Tigray, Ethiopia, 31% of nursing mothers were underweight, and 25% were at risk for chronic energy deficiency due to inadequate caloric intake during lactation. However, compared to urban dwellers, breastfeeding women in southern Ethiopia's rural areas did not acquire enough dietary diversity (Moges *et al*., 2018). Research has shown similar results in other regions of Ethiopia (Beruk *et al*., 2018; Masresha *et al*., 2019; Melaku *et al*., 2019). However, in some regions and cultures of Ethiopian communities, various indigenous fermented foods are made from locally accessible ingredients for all family members or just nursing mothers (Kitessa *et al*., 2022; Binitu *et al*., 2018; Kitessa et al., 2022; Kitessa *et al*., 2023). Such cultural foods are rich in both macro-and micronutrients as they are produced from the combination of grains and have high bioavailability as a result of fermentation. In order to highlight the significance of proper maternal nutrition during breastfeeding for both maternal health and the best possible growth and development of the newborn, this study compares, contrasts, and summarizes the scientific findings on the nutritional needs of nursing mothers.

METHODOLOGY

Literature Search Strategy

A broad and comprehensive literature search was conducted to identify evidence on the nutritional requirements of lactating mothers. Major scientific databases including PubMed, Google Scholar, ScienceDirect, and Web of Science, were queried, alongside authoritative institutional sources such as WHO, FAO, UNICEF, and national health ministry repositories. Publications from **2014 to 2024** were prioritized to ensure the inclusion of current scientific perspectives, although earlier seminal studies were incorporated when essential for explaining key physiological processes associated with lactation. The search strategy utilized combinations of keywords and Boolean operators (AND/OR), including terms such as maternal nutrition, nutrient requirements during lactation, breastfeeding mothers, macronutrient intake, and micronutrient deficiency. This flexible search approach ensured sensitivity to a wide range of relevant literature.

Inclusion and Exclusion Criteria

Studies were included if they explored nutrient requirements, dietary intake, nutrient metabolism, or determinants of nutritional status among lactating women. Eligible sources comprised peer-reviewed research articles, systematic and narrative reviews, national dietary guidelines, and reports from reputable international organizations. Regional studies from low- and middle-income countries were prioritized due to their contextual relevance, though global recommendations applicable to such settings were also considered. Only English-language publications were reviewed. Exclusion criteria eliminated studies focusing exclusively on pregnant women, infants, or general adult populations, as well as papers lacking scientific relevance, methodological clarity, or direct applicability to maternal nutrition during lactation.

Screening and Selection of Studies

The selection process proceeded in two stages. First, titles and abstracts were screened to remove duplicates and clearly irrelevant publications. Second, full texts of potentially relevant articles were reviewed to confirm their alignment with the objectives of the narrative review. Studies were retained when they demonstrated scientific credibility, clear relevance to lactation-specific nutrition, and applicability to low-income or sub-Saharan African contexts. Because this study is a narrative review, no formal quality appraisal tools were applied; instead, emphasis was placed on coherence, scientific soundness, and contribution to thematic understanding.

Data Extraction and Organization

Information from included studies was manually extracted and organized into major thematic categories. Extracted data included publication details, study setting, design features, reported nutrient requirements, physiological mechanisms, maternal dietary practices, and factors influencing nutritional intake during lactation. This information was grouped into categories such as macronutrient requirements, micronutrient needs, mineral homeostasis, sociocultural and economic determinants of maternal nutrition, and region-specific evidence from Ethiopia. When nutrient requirement values were reported, they were documented for comparison with WHO/FAO recommendations.

Synthesis of Evidence

A narrative synthesis approach was used to integrate findings from diverse study designs. Extracted evidence was examined for areas of agreement, variation, or uncertainty across studies. The synthesis emphasized key physiological considerations, regional dietary patterns, factors affecting maternal nutrition, and broader policy implications. Gaps in existing research were identified to highlight areas requiring further investigation.

LITERATURE REVIEW

Nutritional Requirements of Lactating Mothers

Energy and Carbohydrate Requirements during Lactation

Lactation is the most energy-demanding period of all human reproductive stages. The energy required to produce one liter of breast milk is estimated to be about 700 kcal, and the total energy needed for milk secretion during the first four months of lactation is roughly equivalent to the energy cost of the entire pregnancy (Pados & Camp, 2024 further reported that the energy cost of exclusive breastfeeding is approximately 2.62 MJ/day, based on a mean daily milk production of 749 g, an energy density of 2.8 kJ/g, and an energetic efficiency of 0.80. Evidence suggests that mothers who consume more food than they did before pregnancy are generally able to meet the energy demands of lactation and successfully breastfeed (King et al., 2021). Conversely, Ayse (2013) reports that women who consume less than the recommended dietary intake may gradually lose weight during lactation. Part of the energy required for breastfeeding is supported by the weight accumulated during pregnancy. Overall, the recommended increase in maternal energy intake during lactation is approximately 500 kcal/day above basal energy needs, which typically range from ≈ 2200–3600 kcal/day (FAO/WHO, 2004). However, basal energy requirements vary based on height, physical activity level, and maternal weight status (Tanaka & Tanaka, 2006).

Carbohydrates play a central role in meeting these elevated energy needs during lactation. As the primary nutritional source of energy, cereals provide a major share of dietary carbohydrates (Temba, 2016). During breastfeeding, the body requires additional carbohydrates to support the energy demands of milk synthesis and to help conserve maternal protein stores (Thompson & Manore, 2005). Lactose, the main carbohydrate in human milk, is synthesized from glucose, and its concentration, approximately 74 g/L, remains relatively constant throughout lactation regardless of maternal dietary intake (Segura *et al*., 2016). In addition to supporting milk production, adequate carbohydrate intake is essential for various micronutrient functions (Takimoto et al., 2017). The US and Canadian RDAs recommend that breastfeeding mothers consume 210 g of carbohydrates per day, which is 80 g more than the RDA for non-pregnant, non-lactating women (Sehgal *et al*., 2024).

Protein requirements during lactation

Proteins are necessary for building and repairing tissues, synthesizing hormones, enzymes, and antibodies, maintaining fluid and electrolytes, and maintaining acid-base balance (Bender, 2022). Insufficient energy consumption, however, causes proteins and amino acids to change their primary function to energy generation (Innis, 2018). Protein is found in both plants and animals, although in different forms and quantities. For example, animal-derived proteins are frequently of higher quality than plant-derived proteins because of their digestibility, efficacy, and percentage of important amino acids (McIntyre et al., 2023). However, by offering protein that has all of the necessary amino acids, legumes improve the quality of protein and serve as a good supplement to cereal grains. Furthermore, food products' protein content can be increased in terms of both quality and quantity by processing techniques like fermentation. Because animal products are not readily available or reasonably priced, the production and fermentation of plant-based diets helps to fill the protein gap experienced by nursing moms.

The quality of maternal diet determines the amount of protein in human milk (Savitikadi *et al*., 2021). According to some research, the colostrum and breast milk of undernourished nursing mothers have lower protein levels than those of moms who get the daily required allowance (Savitikadi *et al*., 2021). Furthermore, data from other studies indicate that the amount of protein in breast milk is directly correlated with the amount of protein supplemented in the diet of nursing women (Binder *et al*., 2023). According to reports, nursing mothers' lean body mass is protected from depletion when they consume more than 1 g/kg of protein every day (Perrella *et al*., 2021). Furthermore, protein supplementation raises the amount of protein in human milk and contributes to infants' daily weight gain. According to reports, nursing mothers' lean body mass is protected from depletion when they consume more than 1 g/kg of protein every day (Perrella *et al*., 2021). Furthermore, protein supplementation raises the amount of protein in human milk and contributes to infants' daily weight gain.

Dietary fat requirements during lactation

Fat functions as a mechanism for the absorption of fat-soluble vitamins, is a concentrated energy source with flavor, and is a necessary structural component of living things (Sokoła-Wysoczanska et al., 2018). Triglycerides, which are divided into saturated, monounsaturated, and polyunsaturated fatty acids (PUFAs), make up the majority of dietary fat. Fatty acids come from a variety of fat sources. Mono- and polyunsaturated fatty acids, for instance, are abundant in the oils of maize and rapeseed (Sanjeev et al., 2014; Sagan *et al*., 2019; Jouanne *et al*., 2021). Additionally, pregnant women and nursing moms may benefit from the good oxidative stability that comes from consuming dietary fat from these sources, especially when under stress.

Human milk provides a balanced diet for babies because it contains fat, which makes up slightly more than half (52%) of its nutritional composition (Adhikari *et al*., 2022). Very low maternal dietary fat consumption may lead to low breast milk fat content because of the strong relationship between nutrition and breast milk fat content (McIntyre *et al*., 2023). Maternal diets with adequate energy but low dietary fat result in breast milk with a higher concentration of medium-chain fatty acids produced by the breast, whereas diets low in both total energy and total dietary fat cause breast milk with a fatty acid composition from maternal body fat depletion, which causes maternal weight loss. In contrast, one study in the USA confirmed that replacing animal fat with vegetable fat increased the long-chain fatty acids and linoleic acid in human milk (Chamorro et al., 2022).

The amount of omega-3 and omega-6 fatty acids in human milk is a reflection of the mother's diet since moms who consume large amounts of these essential fatty acids may give their babies lots of them (Shibabaw, 2021). According to Chamorro et al., (2022), the first advantages of omega-3 fatty acids for nursing moms include enhanced lipid profiles and associated anti-inflammatory qualities that strengthen the cardiovascular system.

Dietary fiber requirements during lactation

Dietary fibers, such as non-starch polysaccharides, resistant starch, and lignin, are found in all plant materials. For example, ‘barley, one of the major ingredients of Shameta, is a rich source of β-glucan that is fermented by microorganisms in the large intestine to produce short-chain fatty acids, which are used as an energy source and to prevent colon cancer (Miyamoto *et al*., 2018; Kitessa *et al*., 2022). Oligosaccharides, found in fava beans, another Shameta minor ingredient, are also used as prebiotic soluble fibers for the infant’s gut and ensure proper immune responses (Venter *et al*., 2022; *Çavdar et al*., 2019; Kitessa *et al*., 2022). An adequate intake of dietary fiber is essential for proper gut function and regular bowel movements. It reduces gastrointestinal diseases, constipation, colon cancer, obesity, stroke, cardiovascular diseases, and diabetes (Otles and Ozgoz, 2014). The importance of fiber in maternal nutrition is related to improved digestion and regulation of glucose metabolism (Shen et al., 2024).

Table 1. Macronutrient Requirements for Lactating Mothers

Nutrient	Recommended Intake for Lactating Mothers	Physiological Role During Lactation	References
Energy	+500 kcal/day above basal needs (≈ 2200–3600 kcal/day depending on activity & weight)	Supports milk production (≈700 kcal needed per liter of milk)	Albracht-Schulte *et al*., 2023
Protein	>1 g/kg/day	Required for milk protein production, maternal tissue repair, enzyme function, and antibody formation	Rasmussen *et al*., 2020
Carbohydrates	210 g/day	Primary energy source; needed for lactose synthesis	Ding *et al*., 2020
Fat	No specific RDA; adequate intake of essential fatty acids required	Provides 52% of breast milk energy; supports brain and retinal development	Patro-Golab et al., 2024
Dietary Fiber	~25–30 g/day (general recommendation)	Supports digestion, glucose regulation, gut health	McIntyre *et al*., 2023; Çavdar *et al*., 2019

Mineral requirements during lactation

Maternal micronutrient status should be viewed from the preconception period throughout pregnancy and lactation, as it determines pregnancy outcomes, infant growth and development, and maternal health (Cetin *et al*., 2019). During lactation, many minerals are not significantly altered because of maternal homeostatic processes (Kovacs, 2016). Most of these minerals are transferred into milk by active transfer, which causes variations in the maternal mineral status during lactation (Obeagu, 2025). However, Cetin *et al*., 2019) reported that during lactation, maternal status or the intake of minerals strongly affects breast milk concentration and has the potential to affect maternal health.

Iron is present in hemoglobin as a carrier of oxygen in the bodies of living things, and approximately 25% is present as ferritin iron stores in the liver, which is used for different functions (Chilot *et al*., 2023). There are two types of iron in the diet: heme and non-heme iron. Heme iron from meat and meat products is typically 20-30% absorbed, while non-heme iron from plant-based foods has an absorption rate of not more than 5%. However, the fermentation of plant-based foods such as Shameta changes non-heme iron to heme iron and improves its bioavailability to significant levels (Pranoto *et al*., 2013; Day and Morawicki, 2016). In addition, during new product development or food modification, the formulation of cereal grains with legumes is crucial for improving mineral content, as legumes have a higher mineral content than cereal grains (Rajnincova *et al*., 2019).

Iron requirements in breastfeeding women are substantially lower than those in pregnant, non-pregnant, and non-lactating mothers (Billeaud et al., 2021). The RDI for breastfeeding women aged 19–50 years is 9 mg/day, while it is 10 mg/day for breastfeeding adolescent women aged between 14 and 18 years (Marques *et al*., 2014), which is half of the RDI (18 mg/day) for non-pregnant and non-breastfeeding women. This might be due to the assumption of no menstruation during the first six months postpartum, accumulation of iron during prenatal formation, and low iron content in breast milk (Mawani *et al*., 2016). However, in developing countries, iron deficiency and related anemia affect approximately 50% of women of childbearing age (Khayat and Fanaei, 2017).

Calcium and phosphorus are required for the normal development and maintenance of the skeleton, as they build the structure and provide strength to bones and teeth. Calcium is an essential micronutrient for pregnant women, lactating mothers, and newborns (Kovacs, 2016). It is a significant component of breast milk. In contrast, phosphorus retention is also related to bone mineralization and lean body mass accretion during pregnancy and lactation, which are very important for infant growth and development (Filippini *et al*., 2019). Pregnancy and lactation are accompanied by physiologically up regulated bone absorption in response to the calcium demands of the developing fetus and nursing infant (Kovacs, 2016). The average daily transfer of calcium into breast milk is 210 mg and is triple in some women nursing twins (Kovacs, 2016). The transfer of calcium to breast milk is facilitated by the upregulation of calcium absorption by the mother, conservation via the kidney, and mobilization of calcium from the bone through physiological responses (Al-Bashaireh *et al*., 2018). Low calcium intake may lead to bone density loss during lactation, resulting in bone fractures in women (MOH, 2006; Kovacs, 2016).

Bone calcium reserves are affected by dietary calcium intake, vitamin D status, dietary sodium, phosphorus, protein, caffeine, and acidifying and alkaline agents (MOH, 2006). Moderate physical activity fairly increases bone mineral density; however, even if the consumption of calcium-rich foods is adequate, alcohol consumption and cigarette smoking may gradually decrease bone density (Ram *et al*., 2020), which is dangerous for both lactating mothers and pregnant women. According to Ram *et al*., 2020, the RDI for pregnant and breastfeeding women aged 19 years and over is 1000 mg/day, while it is 1300 mg/day for pregnant and breastfeeding women aged between 14 and 18 years. Likewise, the RDI of phosphorus for breastfeeding women is 1000 mg/day.

Zinc is essential for growth and neurobehavioral development, immune functions, reproduction, and stabilization of membranes. The bioavailability of zinc in foods depends on the content of anti-nutritional factors which are reduced to significant levels during fermentation (Dumrongwongsiri *et al*., 2022;Day and Morawicki, 2018). Zinc is an essential micronutrient for milk secretion during the lactation period (Khayat *et al*., 2017). It has been reported that breastfeeding might deplete maternal zinc stores because of the greater need for zinc during lactation, especially during the early weeks postpartum (Aparicio et al., 2020 reported that an adequate supply of zinc in the diet or as a supplement is essential for the normal growth and development of the fetus and infants.

The recommended daily intake (RDI) of Zn during pregnancy and lactation ranges between 4.3 to 19 mg/day and varies depending on the post-partum period and bioavailability (Billeaud et al., 2021). However, Winiarska-Mieczan, (2014) reported that the RDI for breastfeeding women aged between 14–18 years is 11 mg/day, and 12 mg/day for women aged between 19–50 years. It has been reported that an intake of 13 mg/day during lactation is adequate; however, increasing intakes beyond this does not affect the concentration of Zn in breast milk (H Nielsen, 2018).

Magnesium is found in the skeleton and soft tissues, which are required for energy production and bone metabolism. Although moderate deficiency of magnesium brings chronic diseases, the results of studies on the effects of magnesium deficiency are not reliable Jouanne *et al*., 2021).

Table 2. Mineral Requirements for Lactating Mothers

Nutrient	Recommended Intake for Lactating Mothers	Physiological Role During Lactation	References
Iron	9 mg/day (19–50 years (yrs)), 10 mg/day (14–18 yrs)	Prevents anemia; supports maternal recovery	Cai *et al*., 2020
Calcium	1000 mg/day (19+ yrs), 1300 mg/day (14–18 yrs)	Supports milk calcium secretion (~210 mg/day); bone maintenance	Bzikowska-Jura *et al*., 2023
Phosphorus	1000 mg/day	Bone mineralization; energy metabolism	Gibson *et al*., 2016
Zinc	11 mg/day (14–18 yrs), 12 mg/day (19–50 yrs)	Immune function, growth, neurological development	Khayat & Fanaei, 2017
Magnesium	360 mg/day (14–18 yrs), 310 mg/day (19–30 yrs), 320 mg/day (31–50 yrs)	Energy metabolism; bone health	Ding *et al*., 2020
Sodium	460–920 mg/day (AI); UL = 2300 mg/day	Fluid balance, nerve function	Cabezuelo *et al*., 2019; WHO, 2015; Mecawiet al., 2015

Institute of Medicine, (1997) reported that poor magnesium status in the maternal diet during pregnancy has been implicated with foetal growth retardation, cerebral palsy, and mental retardation among newborns. It has been reported that low intakes of magnesium may negatively affect pregnancy outcomes (Fanni *et al*., 2021). The RDI of magnesium is 360, 310, and 320 mg/day for breastfeeding women aged between 14-18, 19-30, and 31-50 years, respectively (Oria et al., 2019). However, there is no difference in the RDIs for breastfeeding women, non-pregnant women, and non-breastfeeding women.

Sodium supplementation in the diet is important for conserving and improving the taste of foods (WHO, 2015). Sodium is the most abundant electrolyte found in extracellular fluid for the maintenance of arterial pressure, although excessive consumption brings side effects on human beings (WHO, 2015; Mecawiet al., 2015). However, Song et al. (2023) reported that a high sodium diet during pregnancy and lactation may produce disturbances in offspring, leading to higher blood pressure. However, the adequate intake (AI) of sodium in breastfeeding women aged 14–50 years is 460–920 mg/day. The UL for sodium is 2300 mg/day during pregnancy and breastfeeding (da Silva et al., 2019).

Vitamin Requirement during Lactation

The requirement of vitamins in a lactating mother increases significantly to support both her health and the growth and development of her baby. During lactation, a mother's body produces nutrient-rich breast milk, and this process demands higher levels of certain vitamins. Specifically, they need more vitamin A, B12, C, and D compared to non-lactating women. However, the rest vitamins are also important for both mothers and their infants.

During lactation, vitamin A is important for maintaining healthy vision, immune function, and cell growth and differentiation in both the mother and her breastfeeding infant (Berliana et al., 2019). Its recommended nutrient intake for postpartum women is 850 µg retinol equivalents (RE)/day, which is substantially higher than the 770-mcg recommended during pregnancy (Hoque *et al*., 2023). During lactation, the breast milk of well-nourished mothers is rich in vitamin A and it's the best source for the infant, as they are born with low body stores of vitamin A (WHO, 2011b). Therefore, mothers are encouraged to exclusively breastfeed for the first 6 months postpartum. Vitamin A deficiency remains a public health problem among women and children, affecting an estimated 190 million preschool-age children and 19 million pregnant women, with the highest burden in the regions of Africa and South-East Asia (Aserese *et al*., 2020).

During lactation, maternal dietary intake of vitamin A is directly proportional to breast milk vitamin A concentrations (Duggan et al., 2014). Therefore, during the lactation period programmes such as supplementation, dietary diversification, and food fortification with vitamin A can improve the vitamin A content of breast milk (Martysiak-Żurowska *et al*., 2016). The dietary vitamin A and provitamin A rich foods are vegetables such as carrot, pumpkin, papaya and red palm oil, and animal foods such as dairy products (whole milk, yogurt, and cheese), liver and fish oils (Durá-Travé & Gallinas-Victoriano, 2023).

Table 3. Vitamin Requirements for Lactating Mothers

Nutrient	Recommended Intake for Lactating Mothers	Physiological Role During Lactation	References
Vitamin A	850 µg RE/day	Vision, immune function; supports infant stores	da Silva et *et al*., 2019
Vitamin B12	~2.8 µg/day	Nerve function, RBC formation; infant neurodevelopment	Singh *et al*., 2025 ; Hanna *et al*., 2022
Vitamin C	120 mg/day	Antioxidant defense, collagen synthesis	Zarban *et al*., 2015 ; Martysiak-Żurowska *et al*., 2016
Vitamin D	600 IU/day (15 µg)	Calcium absorption; bone health	Halliwell, 2024; Ares *et al*., 2016;
Vitamin E	19 mg/day	Antioxidant protection for mother and infant	Mubeen *et al*., 2025; Xi *et al*., 2022
Vitamin K	No specific increased RDA	Blood clotting; bone health	Kaisar *et al*., 2021; Ares *et al*., 2016

The Vitamin B group, a collection of eight essential water-soluble vitamins, plays crucial roles in various bodily functions, including energy production, cell growth, and nerve function (Hanna et al., 2022). During lactation, adequate intake of B vitamins is crucial for both the mother and the infant. Specifically, vitamin B12, folate, thiamin, riboflavin, and B6 are vital for the infant's neurological development, red blood cell production, and overall growth (Chen *et al*., 2021). Maternal deficiency in these vitamins can lead to lower concentrations in breast milk and potentially affect the infant's health.

Vitamin D is important for calcium absorption and bone health (Thorne-Lyman and Fawzi, 2012; Ares *et al*., 2016). The requirement of this vitamin is ~600 IU/day (15 mcg). During lactating period, supplementation may be needed if sun exposure is low or if the mother is deficient. Vitamin D deficiency is fairly frequent in lactating mothers due to restricted diets, lack of sufficient sunlight, and/or dark skin. However, the transfer of maternal vitamin D to milk is poor; thus, infants need sufficient sunlight or supplementation (Ares et al., 2016).

Vitamin C and E are used as antioxidant activities of breast milk (Chen *et al*., 2021). Lactating women have increased vitamin C and E requirements compared to non-pregnant, non-lactating women. The recommended daily allowance (RDA) for vitamin C during lactation is 120 mg, an increase of 45 mg over the RDA for non-lactating women (Martysiak-Żurowskaet al., 2016). For vitamin E, the RDA is 19 mg during lactation, an increase of 4 mg compared to non-lactating women (Xi *et al*., 2022). These higher requirements are due to the transfer of these vitamins into breast milk and their importance for both the mother's and the infant's health.

Vitamin K is an essential fat-soluble vitamin with critical roles in blood clotting, and for the health of bone, cardiovascular, and cognitive (Kaisar *et al*., 2021). In addition to vitamin K available in the diet, there is synthesized in the body by microflora. As a result, vitamin K supplementation is not much required. However, the newborns usually have low levels of vitamin K, as it is low mobilization through the placenta and in an adequate number of bacterial flora in newborns. Thus, supplementation is recommended to prevent vitamin K deficiency diseases in newborns (Ares *et al*., 2016).

Phytochemical requirement during lactation

Oxidative stress, a condition where the production of reactive oxygen species surpasses the concentration of available antioxidant molecules, plays a crucial role in mediating cell and tissue damage (Singh *et al*., 2025). While biological molecules in the human body are vulnerable to oxidative stress, it can be mitigated by maintaining a critical oxidation-reduction balance through the consumption of foods rich in phytochemicals (Halliwell, 2024). Phytochemicals, secondary plant metabolites, are believed to offer health benefits by protecting against oxidative stress and inflammation. Their presence in the maternal diet is vital, as it shields both mothers and infants from oxidative stress (Fenga *et al*., 2016). Tsopmo (2018) noted that consuming antioxidant-rich foods enhances the health of lactating mothers and infants. It has been observed that an increase in polyphenols in the maternal diet is directly proportional to the antioxidant capacity of breast milk (Franke *et al*., 2006). Additionally, Silva *et al*. (2019) reported that the presence of isoflavones in the maternal diet is directly related to their concentrations in an infant's blood.

DISCUSSION

Dietary intake during the lactation period often falls below recommended levels, despite the increased physiological demands associated with breast milk production. Studies repeatedly demonstrate that many lactating mothers do not consume adequate energy, protein, and key micronutrients, especially iron, calcium, vitamin A, iodine, zinc, and the B-vitamins during this period. These deficiencies have implications for both maternal well-being and, for certain nutrients, the micronutrient content of breast milk. Although breast milk production is prioritized by homeostatic mechanisms, prolonged dietary inadequacy can diminish the nutrient density of milk, underscoring the need to optimize maternal nutrition.

A recurrent theme across the literature is the low dietary diversity among lactating women. Maternal diets remain heavily dependent on cereal-based staples, with limited intake of animal-source foods, fruits, and vegetables. This dietary pattern is influenced by economic hardship, seasonal variability in food availability, low-income household settings, and weak integration of nutrition-sensitive agricultural practices. In many low-resource contexts, including Ethiopia, household food insecurity further compromises the ability of lactating mothers to meet daily nutrient requirements. Cultural beliefs and taboos, such as avoiding eggs, meat, or certain vegetables during lactation also limit dietary variety and contribute to micronutrient deficiencies. Although these practices differ across regions, they share the common consequence of reducing the nutrient adequacy of maternal diets at a time of increased requirement.

The literature also emphasizes a persistent gap in maternal nutrition knowledge, particularly regarding the increased energy and micronutrient needs during lactation. Many women are unaware of the heightened requirements for vitamins A, B12, C, and D, or the importance of nutrient-rich foods for supporting milk production and maintaining maternal health. Limited counseling during antenatal and postnatal care, inadequate interaction with trained health workers, and inconsistent community-level nutrition messaging weaken efforts to promote optimal dietary practices. Conversely, studies show that targeted nutrition education, delivered through community health workers, mother support groups, and mass communication channels, can significantly improve dietary behavior, highlighting the continued potential of knowledge-based interventions.

Moreover, the review reaffirms the strong link between maternal dietary intake and infant nutrition outcomes. While exclusive breastfeeding rates may be adequate, insufficient maternal nutrient intake can compromise the transfer of micronutrients such as vitamin A, B12, iodine, folate, and essential fatty acids, placing infants at higher risk of impaired growth, reduced immunity, and developmental delays. Consequently, strengthening maternal nutrition is not only critical for mothers but serves as a cornerstone for achieving optimal infant growth, cognitive development, and long-term health.

Despite the challenges identified, the literature presents several promising strategies for improving maternal dietary adequacy during lactation. Nutrition-sensitive agricultural interventions such as home gardening, poultry production, small livestock rearing, and aquaculture show consistent benefits in increasing household access to diverse foods, particularly animal-source foods and vegetables. Social and behavior change communication (SBCC) approaches have proven effective when culturally appropriate and embedded within existing community structures. Complementary measures such as cash transfers, food fortification, and targeted micronutrient supplementation can further improve dietary adequacy when supported by functional health systems and community engagement.

Overall, the reviewed evidence indicates that enhancing dietary intake during the lactation period requires coordinated multi-sectoral action, integrating the health system, agriculture, education, and social protection sectors. Isolated interventions, whether counseling alone, supplementation alone, or agricultural improvements alone, are insufficient to address the complex determinants of poor maternal diet. Rather, the most effective approaches combine nutrition education, economic and social support, food diversification, and enabling policy frameworks that enhance maternal access to nutritious foods. These insights form a foundation for formulating policy actions and identifying future research priorities aimed at improving maternal and infant nutrition during the lactation period.

CONCLUSION

This narrative review demonstrates that the lactation period is one of the most nutritionally demanding stages of a woman's reproductive life, requiring increased intake of energy, macronutrients, and key vitamins and minerals to support both maternal well-being and the production of nutritionally adequate breast milk. While physiological mechanisms help maintain the mineral composition of breast milk through regulated absorption, mobilization, and excretion, the quality of several nutrients, particularly proteins, fats, and micronutrients such as vitamins A, B12, C, and D, remains closely linked to maternal dietary intake. Prolonged dietary inadequacy can reduce the micronutrient density of breast milk and compromise maternal health.

The evidence underscores the need for lactating mothers to consume a diversified and nutrient-dense diet that meets elevated requirements for calories, proteins, essential fatty acids, and micronutrients. In settings where dietary diversity is limited or where intake falls short of recommended allowances, targeted interventions such as nutrition counseling, food-based strategies, fortified foods, and micronutrient supplementation may be necessary to fill nutritional gaps. Ensuring optimal maternal nutrition during lactation is therefore essential not only for maintaining maternal health and physiological stability but also for supporting infant growth, immune function, and overall development.

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The authors declare that they have no conflict of interest.

REFERENCES

Adhikari S, Kudla U, Nyakayiru J, Brouwer-Brolsma EM. (2022). Maternal dietary intake, nutritional status and macronutrient composition of human breast milk: Systematic review. British Journal of Nutrition. 127(12):1796–1820.

Ahmed F, Malik NI, Shahzad M, Ahmad M, Shahid M, Feng XL, Guo J. (2022). Determinants of infant young child feeding among mothers of malnourished children in South Punjab, Pakistan: A qualitative study. Frontiers in Public Health. 10:834089.

Ahmed WAM, Ahmed EA, Arafa KAO, El-Amin EIS, Alostaz ZM, Khalid KE. (2014). Nutritional status of mothers and its determinants in Alemtidad area, Khartoum. Food and Nutrition Sciences. 5:2203–2208.

Alemayehu M, Argaw A, Mariam AG. (2015). Factors associated with malnutrition among lactating women in subsistence farming households from Dedo and Seqa-Chekorsa districts, Jimma Zone. Developing Country Studies. 5:117–118.

Al-Bashaireh AM, Haddad LG, Weaver M, Chengguo X, Kelly DL, Yoon S. (2018). The effect of tobacco smoking on bone mass. Journal of Osteoporosis. 2018:1206235.

Albracht-Schulte KD, García-González Á, Wilson S, Robert-McComb JJ. (2023). Nutritional guidelines and energy needs during pregnancy and lactation for active women. In: The Active Female. pp. 363–378.

Aparicio E, Jardí C, Bedmar C, Pallejà M, Basora J, Arija V; ECLIPSES Study Group. (2020). Nutrient intake during pregnancy and post-partum: ECLIPSES study. Nutrients. 12(5):1325.

Ares SS, Arena AJ, Marta DN. (2016). La importancia de la nutrición materna durante la lactancia. Anales de Pediatría. 84:347.

Aserese AD, Atenafu A, Sisay M, Sorrie MB, Yirdaw BW, Zegeye MK. (2020). Adequate vitamin A rich food consumption among lactating mothers. PLoS ONE. 15(9):e0239308.

Beal T, Manohar S, Miachon L, Fanzo J. (2024). Nutrient-dense foods and diverse diets. Proceedings of the National Academy of Sciences (PNAS). 121(50):e2319007121.

Bender DA. (2022). The metabolism of "surplus" amino acids. British Journal of Nutrition. 108(S2):S113–S121.

Berliana I, Munayarokh M, Rofi'ah S. (2019). Correlation between consumption of vitamin A and breast milk adequacy. Midwifery and Nursing Research. 1(2):76–82.

Desalegn BB, Lambert C, Riedel S, Negese T, Biesalski HK. (2018). Ethiopian Orthodox fasting and lactating mothers: Longitudinal study on dietary pattern and nutritional status in rural Tigray, Ethiopia. International Journal of Environmental Research and Public Health**.** 15(8):1767.

Billeaud C, Brines J, Belcadi W, Castel B, Rigourd V. (2021). Nutrition of pregnant and lactating women. Healthcare. 10(1):65.

Binitu WB, Gemede HF, Woldegiorgis AZ. (2018). Nutritional and alcoholic contents of cheka. Food Science and Nutrition. 6:2466–2472.

Binder C, Baumgartner-Parzer S, Gard LI, Berger A, Thajer A. (2023). Maternal diet influences human milk protein concentration. Nutrients. 15:433.

Bzikowska-Jura A, Wesołowska A, Sobieraj P, Michalska-Kacymirow M, Bulska E, Starcevic I. (2023). Maternal diet and calcium/phosphorus in human milk. Journal of Human Nutrition and Dietetics. 36(3):798–809.

Cabezuelo MT, Zaragozá R, Barber T, Viña JR. (2019). Role of vitamin A in mammary gland development. Nutrients. 12(1):80.

Cai G, Tian J, Winzenberg T, Wu F. (2020). Calcium supplementation improves bone density in lactating women: A randomized trial. American Journal of Clinical Nutrition (AJCN). 112(1):48–56.

Çavdar G, Papich T, Ryan EP. (2019). Microbiome, breastfeeding and public health policy. Nutrition and Metabolic Insights. 12:1–10.

Cetin I, Bühling K, Demir C, Kortam A, Prescott SL, Yamashiro Y, Yarmolinskaya M, Koletzko B. (2019). Micronutrient status during pregnancy: A critical review. Annals of Nutrition and Metabolism. 74(4):269–278.

Chamorro R, Bascuñán KA, Barrera C, Sandoval J, Puigrredon C, Valenzuela R. (2022). Polyunsaturated fatty acids in breast milk and obesity risk in infants. International Journal of Environmental Research and Public Health (IJERPH). 19(4):1930.

Chen Y, Li T, Ji H, Wang X, Sun X, Miao M, Wang Y, Wu Q, Liang H, Yuan W. (2021). Maternal soy intake and neonatal anthropometry: Evidence from a prospective cohort study. Environmental Pollution. 274:115752.

Chilot D, Aragaw FM, Belay DG, Asratie MH, Bicha MM, Alem AZ. (2023). Anaemia among lactating and non-lactating women: A comparative cross-sectional study in Ethiopia. BMJ Open. 13:e069851.

Ding Y, Indayati W, Basnet TB, Li F, Luo H, Pan H, Wang Z. (2020). Dietary intake and nutritional status among lactating mothers in China: A cross-sectional survey. Nutrition Journal. 19:72.

Day CN, Morawicki RO. (2016). Effect of fermentation on protein digestibility and functional properties of sorghum. Journal of Food Quality. 2018:1–7.

Duggan C, Srinivasan K, Thomas T, *et al*. (2014). Vitamin B-12 supplementation during pregnancy and early lactation improves maternal and infant B-12 status: A randomized controlled trial. Journal of Nutrition. 144(5):758–764.

Dumrongwongsiri O, Winichagoon P, Chongviriyaphan N, Suthutvoravut U, Grote V, Koletzko B. (2022). Zinc and iron adequacy among pregnant and lactating women: A review. Maternal & Child Nutrition. 18:e13268.

Durá-Travé T, Gallinas-Victoriano F. (2023). Pregnancy, breastfeeding and vitamin D: A narrative review. International Journal of Molecular Sciences (IJMS). 24(15):11881.

Fanni D, Gerosa C, Nurchi VM, Fanos V, *et al*. (2021). Magnesium in pregnancy: Maternal, fetal and metabolic implications. Biological Trace Element Research. 199:3647–3657.

Fenga C, Costa C, Caruso E, Raffa L, *et al*. (2016). Polyphenols and breast cancer prevention: Molecular mechanisms. Farmacia. 64:1–12.

Filippini A, D'Amore A, D'Alessio A. (2019). Calcium mobilization in endothelial cells: Mechanisms and signaling pathways. International Journal of Molecular Sciences (IJMS). 20(18):4525.

Gibson RS, King JC, Lowe N. (2016). A review of dietary zinc recommendations. Food and Nutrition Bulletin. 37(4):443–460.

Halliwell B. (2024). Mechanisms of antioxidant action: Updated perspectives. Nature Reviews Molecular Cell Biology. 25(1):13–33.

Hanna M, Jaqua E, Nguyen V, Clay J. (2022). A comprehensive review of B vitamins: Functions, metabolism, and health implications. The Permanente Journal. DOI:10.7812/TPP/21.204.

Hasan MM, Ahmed S, Soares Magalhaes RJ, *et al*. (2022). The double burden of malnutrition in low- and middle-income countries: Trends and drivers. European Journal of Clinical Nutrition (EJCN). 76:277–287.

Hayot N, Fanaei H, Ghanbarzehi A. (2017). Minerals in pregnancy and lactation: A clinical review. Journal of Clinical and Diagnostic Research (JCDR). 11(9):QE01–QE04.

Hoque M, Emon K, Malo PC, *et al*. (2023). Dietary sources of vitamins and minerals among rural households. Indiana Journal of Agriculture and Life Sciences. 3(6):23–31.

Ikpeama C, Uroko F, Ngwu C. (2024). Socio-cultural influence on the knowledge of infant nutrition among mothers in a local council in South-East Nigeria: Implications for social work. Journal of Social Service Research. 50(3):352–362.

Innis SM. (2018). Maternal diet, fatty acids, and infant neurological development. American Journal of Clinical Nutrition (AJCN). 99(3):734S–741S.

Jouanne M, Oddoux S, Noël A, Voisin-Chiret AS. (2021). Nutrient requirements during pregnancy and lactation: A comprehensive review. Nutrients. 13(2):1–17.

Kaisar N, Mhaibes SH, Khalil HH. (2021). Vitamin K and human health: A review. Iraqi Journal of Pharmaceutical Sciences. 30(1):1–13.

Kejela G, Gebremeskel F, Hassen H, Shewangizaw M, Desalegn M. (2019). Magnitude of undernutrition and associated factors among lactating mothers in Southern Ethiopia. Research Square. pp. 6–14.

King, J. C., Butte, N. F., Bronstein, M. N., Kopp, L. E., & Lindquist, S. A. (2021).Energy metabolism during pregnancy. American Journal of Clinical Nutrition, 59(2), 439S–445S.

Kitessa, D. A., Bacha, K., Tola, Y. B., & Murimi, M. (2022). Preparation of Shameta: A traditional fermented food. East African Journal of Sciences, 17, 55–70.

Kitessa, D. A., Bacha, K., Tola, Y. B., Murimi, M., Smith, E., & Gershe, S. (2022). Nutritional compositions of "Shameta"—A traditional fermented dairy product. Heliyon, 8, (Pages 1–10)

Kovacs, C. S. (2016). Maternal mineral and bone metabolism during pregnancy and lactation. Physiological Reviews, 96, 449–547. (Note: Your two Kovacs entries refer to the same article; kept only full/correct one.)

Marques, R. F., Taddei, J. A., Lopez, F. A., & Braga, J. A. (2014). Iron deficiency anemia and breastfeeding. Revista da Associação Médica Brasileira, 60 (1), 18–22.

Martysiak-Żurowska, D., Zagierski, M., Woś-Wasilewska, E., & Szlagatys-Sidorkiewicz, A. (2016). Vitamin C absorption and nutritional status in children. International Journal for Vitamin and Nutrition Research, 86, 81–87.

Masresha, L. S., Maleda, T. I., & Mohammed, G. (2019). Factors associated with malnutrition among children attending Miesso Health Center, Eastern Ethiopia. European Journal of Midwifery, 3, 1–5.

Mawani, M., Ali, S. A., Bano, G., & Ali, S. A. (2016). Iron deficiency anemia among women of reproductive age. Reproductive System & Sexual Disorders, 5(3), 1–5.

Mecawi, A. S., Ruginsk, S. G., Elias, L. L., Varanda, W. A., & Antunes-Rodrigues, J. (2015). Neuroendocrine regulation of hydromineral homeostasis. Comprehensive Physiology, 5(3), 1465–1516.

Melaku, T. E., Alemayehu, D. G., Sofonyas, A. T., Desalegn, T. A., & Bedilu, A. A. (2019). Dietary diversity practice and associated factors among lactating mothers in Ethiopia. International Journal of Scientific Reports, 5(1), 17–23.

Miyamoto, J., Watanabe, K., Kimura, I., & colleagues. (2018). Barley β-glucan improves metabolic conditions via microbiota-mediated activation of bile acid receptors. PLoS ONE, 13(4),. (1–10).

Moges, A., Gudina, E., & Yadeta, D. (2018). Undernutrition and associated factors among adolescent pregnant women in Eastern Ethiopia. Haramaya University Thesis.

Mubeen, B., Hasnain, A., Atif, S., *et al*. (2025). Phytochemicals as therapeutic agents: A comprehensive review. Phyton, 94(7), 1941–1956.

Nielsen, F. H. (2018). Magnesium deficiency and chronic inflammation. Journal of Inflammation Research, 25–34.

Obeagu, E.I. (2025). Iron homeostasis and health. Annals of Medicine and Surgery, 87(6), 3362–3371.

Oria, M., Harrison, M., Stallings, V.A. (2019). Potassium DRIs. National Academies Press.

Ötles, S., Ozgoz, S. (2014). Health effects of dietary fiber. Acta Scientiarum Polonorum, 13, 191–202.

Pados, B.F., Camp, L. (2024). Physiology of human lactation. Nursing for Women's Health, 28(4), 303–314.

Patro-Golab, B., Zalewski, B.M., Kammermeier, M., Schwingshackl, L., Koletzko, B. (2024). Fat intake guidelines. Annals of Nutrition and Metabolism, 80, 1–20.

Perrella, S., Gridneva, Z., Lai, C.T., *et al*. (2021). Human milk composition. Seminars in Perinatology, 45, 151380.

Rajnincová, D., Špaleková, A., Gálová, Z., Romanová, K. (2019). Protein profile of cereals. Journal of Food Science and Technology, 49–52.

Ram, S., Narwal, S., Gupta, O.P., Pandey, V., Singh, G.P. (2020). Anti-nutritional factors. In Wheat and Barley Grain Biofortification, 101–128.

Rasmussen, B., Ennis, M., Pencharz, P., Ball, R., Courtney-Martin, G., Elango, R. (2020). Protein requirements of lactating women. Current Developments in Nutrition, 4, nzaa049_046. Rasmussen, K.M. (1992). Influence of maternal nutrition on lactation. Annual Review of Nutrition, 12, 103–117.

Sagan, A., Blicharz-Kania, A., Szmigielski, M., *et al*. (2019). Rapeseed oil enriched with linolenic acid. Sustainability, 11, 1–9.

Sánchez, C., Franco, L., Regal, P., Lamas, A., Cepeda, A., Fente, C. (2021). Breast milk functional compounds. Nutrients, 13(3), 1026.

Sanjeev, P., Chaudhary, D.P., Sreevastava, P., *et al*. (2014). Fatty acid profile of maize. JAOCS, 91, 1001–1005.

Savitikadi, P., Pullakhandam, R., Kulkarni, B., *et al*. (2021). Maternal low-protein diets. Nutrients, 13(11), 4129.

Segura, S.A., Ansótegui, J.A., Díaz-Gómez, N.M. (2016). Maternal nutrition during breastfeeding.Anales de Pediatría, 84(6), 347-e1.

Sehgal, S., Gupta, S., Mishra, M.K. (2024). Electrolytes and acid-base disorders. Springer Nature.

Shen, H., Chen, D., Wang, S., Jin, Y., Cheng, W. (2024). Dietary fiber in pregnant women. Food & Function, 15(12), 6597–6609.

Shenoy, S., Sharma, P., Rao, A., *et al*. (2023). Interventions to reduce maternal malnutrition. Frontiers in Health Services, 3, 1155928.

Shibabaw, T. (2021). Omega-3 PUFA mechanisms. Molecular and Cellular Biochemistry, 476, 993–1003.

Singh, V., Kaur, R., Singh, R., et al. (2025). Vitamins & minerals for infants. Springer Nature. Sokoła-Wysoczańska, E., Wysoczański, T., Wagner, J., *et al*. (2018). PUFA and cardiovascular disorders. Nutrients, 10, 1–13.

Song, P., Adeloye, D., Li, S., *et al*. (2023). Vitamin A deficiency in LMICs. Journal of Global Health, 13, 04084.

Takimoto, H., Yoshiike, N., Katagiri, A., Ishida, H., Abe, S. (2017). Nutritional status in Japan. Journal of Obstetrics and Gynaecology Research, 29(2), 96–103.

Temba, M.C. (2016). Quality of maize–groundnut porridges. MSc Thesis, University of Johannesburg.

Tsopmo, A. (2018). Phytochemicals in human milk. Antioxidants, 7, 1–7. Venter, C., Meyer, R.W.,

Greenhawt, M., et al. (2022). Dietary fiber and immune health. Allergy, 77(11), 3185–3198.

Waldby, C., Noble-Carr, D., Carroll, K. (2023). Meanings of breast milk after infant loss. Sociology of Health & Illness, 45(1), 109–127.

Winiarska-Mieczan, A. (2014). Heavy metals in breast milk. Biological Trace Element Research, 157, 36–44.

Zarban, A., Toroghi, M.M., Asli, M., *et al*. (2015). Vitamin C & E supplementation. Breastfeeding Medicine, 10(4), 214–217