

# The Role of Early -Life Nutrition in Preventing Micronutrient Deficiencies Focus on Vitamin D, Omega3 and Iron During the First 1000 Days& Role of Gum Versus Cow Milk in Toddlers' Nutrition

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## Abstract

Optimal nutrition in the first 1000 days of life has a lifelong positive impact on child development. Specific intrauterine and perinatal factors, pathological conditions, and dietary restrictions can represent potential risk factors for micronutrient deficiencies in the first 1000 days of life, which can have negative systemic consequences, the micronutrient status of children should be investigated in order to tailor strategies specific to the individual's metabolic needs, with a particular focus on deficiencies which can impair or delay the physical and cognitive development of children, namely, vitamin B12, vitamin D and folic acid, as well as oligo-elements such as iron, zinc, calcium, sodium, magnesium, and phosphorus, and essential fatty acids such as omega-3. Nutrition is essential for human growth, particularly in newborns and children. An optimal growth needs a correct diet, to ensure an adequate intake of macronutrients and micronutrients. Macronutrients are the compounds that humans consume in largest quantities, mainly classified in carbohydrates, proteins and fats. Micronutrients are instead introduced in small quantities, but they are required for an adequate growth in the paediatric age, especially zinc, iron, vitamin D and folic acid and omega 3.

**Keywords:** Micronutrient; Vit D; Omega 3; Toddler's nutrition; Growth; Infant nutrition; Development

**Abbreviations:** GUM - Growing Up Milk; VIT D - Vitamin D; PUFA - Polyunsaturated Fatty Acid; EPA - Eicosapentaenoic Acid; DHA - Docosahexaenoic; ALA - Alpha-Linolenic Acid

## Introduction

The first 1000 days (conception, pregnancy, and the first two years of life) represent a period of enormous vulnerability to nutritional deficiency as well opportunity for promoting better outcomes in children's lives. The fetuses, infants, and children experience unique physiological changes and have specific nutritional needs [1]. In this context, an optimal nutrition during this time acts as the first line of prevention against developmental shortfalls [2-6]. The traditional concept of optimal nutrition during the first 1000 days of life included only macronutrient and energy balance. This concept was recently extended to include an adequate supplementation of micronutrients, given the evidence that diet influences gene expression through epigenetic mechanisms during the first 1000 days of life. Adequate micronutrient intake is essential for neural, visual, and skeletal system development because of its role in early foetal

organ development and cell differentiation [7-26]. Micronutrient can only be provided by the diet and act as coenzymes in the production of hormones and essential substances for proper growth. Hence, their role in phases of rapid growth as the first 1000 days is essential. There is no definitive evidence on the benefits of supplementation of other micronutrients without demonstrated deficiency, both for lactating mothers and both for breastfed and weaning infants. At the same time, a supplementation of micronutrients become necessary during the first 1000 days of life in infants or children adopting restricted or unbalanced diets and affected by particular diseases [16,27,28]

## Importance of Micronutrients During the First 1000 Days

Micronutrients at significant risk of deficiency during the first 1000 days are reported in **Table 1**. Among those, deficiencies

Table 1: Overview of growing-up milk studies.

	Vitamin D	Iron	Vitamin C	Zinc	Protein	Alpha-linolenic-acid	Essential fatty acids	Vitamin A	Vitamin E	B vitamins
Akkermans et al. 2017 <sup>24</sup>	×	×								
Chouraqui et al. 2019 <sup>27</sup>	×		×				×	×	×	×
Hower et al. 2013 <sup>22</sup>	×									
Ghisolfi et al. 2013 <sup>25</sup>	×	×	×			×				
Lovell et al. 2019 <sup>26</sup>	×	×	×	×	×					
Walton and Flynn 2013 <sup>23</sup>	×	×								
<div><div></div> Supply status using blood levels</div> <div><div></div> Calculated nutrient supply</div>										

of omega-3 fatty acids, vitamins C, B9, B12, and D, and minerals such as iodine and iron seem the most involved in clinical syndromes [1]. It is important to note that unbalanced diets can lead to micronutrient deficiencies even when following an omnivorous diet due to maternal and child undernutrition and food insecurity especially in low-income and middle-income countries. In this paragraph, we have focused on dietary regimens that involve the conscious choice to exclude food groups or the therapeutic necessity to do so.

Vitamin D promotes the absorption of calcium and phosphorus and bone remodeling. Studies also show its anti-inflammatory, anti-tumoral, and cardiovascular protection effects [22]. In vitamin D deficiency, the body absorbs less calcium and phosphate, causing bone disorders associated with bone weakness (rickets in children or osteomalacia in adults). Vitamin D deficiency during pregnancy can cause deficiency in the foetus; sometimes, the deficiency is severe enough to cause osteomalacia in women. Muscle spasms (tetany) caused by a low calcium level in the blood in people may be newborns’ first signs of rickets when severe vitamin D deficiency occurs. If the spasms are severe, they can lead to seizures. In younger children with rickets, the entire skull may be soft. Infants may have difficulty sitting up, crawling, and learning to walk. Closing of fontanelles may take longer. In children older aged one year or more, bone growth may be impaired, resulting in an abnormal spine curvature (scoliosis) and varus or valgus knees. Vitamin D supplementation is advised in all infants for the first year with 400 UI/die, whether breast or formula-fed [20-22,26].

Iron deficiency develops in stages. First, the demand for iron exceeds the amount consumed in the diet, causing the progressive depletion of iron reserves in the bone marrow. When reserves are reduced, the absorption of dietary iron increases to compensate for this deficiency. The deficiency impairs red blood cell synthesis in later stages, ultimately causing anaemia. Severe and prolonged iron deficiency can also cause a functional alteration of cellular enzymes that contain iron. Most iron deficiency symptoms are due to anaemia. In addition, patients may suffer from pica, a compulsive desire to eat non-food substances (e.g., ice, dirt, paint, starch, ash). Other severe deficiency symptoms include skin and mucosal damage, such as glossitis and cheilosis [7,19,20,32].

Omega-3 s is polyunsaturated fatty acid (PUFA) that in-

cludes eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), as well as the essential precursor alpha-linolenic acid (ALA). Omega-3 deficiency is associated with skin problems, mood disorders, and attention deficits and difficulty to concentrate. In the foetus, they act in neuronal and eye development [30,33,34].

Scientific evaluation of growing-up milk (GUM) versus fresh cow milk

GUM was developed in response to this imbalanced nutritional intake of young children. It is specially formulated to meet young children’s needs, containing large amounts of nutrients which they often do not get in sufficient quantities from their diet. Growing-up milk can be described as a “nutrient-optimised” form of cow’s milk, as it replicates low-fat cow’s milk in terms of the nutrients it contains. A number of studies on humans have investigated the extent to which growing-up milk compensates for the nutrient deficiencies described above. Data on the consumption of growing-up milk and its role in nutrition for children between the ages of 1 and 3 is limited, but the studies that have been conducted show that consuming growing-up milk has a positive influence on young children’s nutrient supply. Can growing-up milk improve the supply of critical nutrients? The table below gives an overview of growing-up milk studies and the observed improvement in nutrient intake and supply

Overview of studies on the effects of growing-up milk

These products are usually referred to as growing-up milk (GUM). However, the term “Young Child Formula” (YCF) is also used by some studies and organisations. The terms are interchangeable. Influence on the supply of micronutrients and macronutrients A prospective, randomised, double-blind, controlled intervention study tested whether growing-up milk with high vitamin D content contributes to improved vitamin D supply in the winter months, and whether enriching growing-up milk with vitamin D can be regarded as safe the whole year round. Over a period of 10 months, children were given either a growing-up milk enriched with vitamin D (2.85 µg per 100 ml = 115 IU) or semi-skimmed cow’s milk with a natural vitamin D content (0.03 µg per 100 ml). The vitamin D supply at the start of the study was more or less the same in both groups (21.5 vs. 18.4 ng/ml 25(OH)D in serum). By the end of the five-month winter period, the children in the growing-up milk group had been supplied with significantly more vitamin

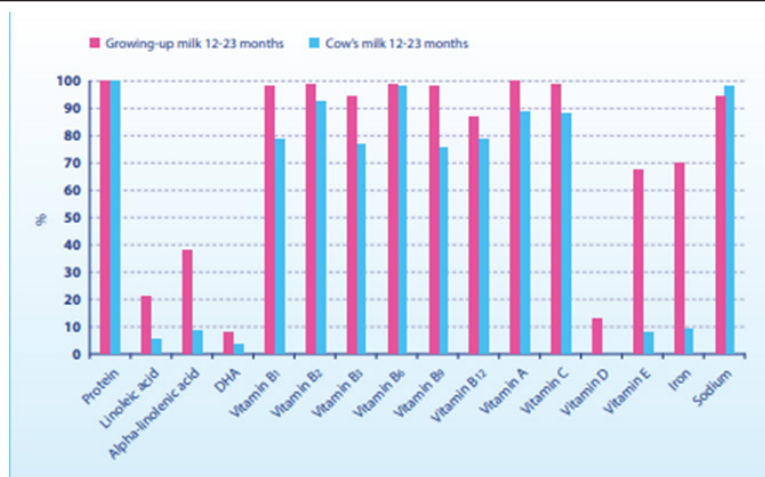


Figure 1: Adherence to EFSA recommendations when consuming growing-up milk vs. cow's milk or dairy products at the age 12–23 months [37].



Figure 2: Adherence to EFSA recommendations when consuming growing-up milk vs. cow's milk or dairy products at the age 24–35 months [37].

D. Their vitamin D levels were in the ideal range (24.8 ng/ml 25(OH)D). In contrast, the levels in the children from the control group were in the subclinical deficiency range (13.6 ng/ml 25(OH)D). During the summer, when we produce more of our own vitamin D in our skin, the 25(OH)D serum concentration in the growing-up milk group increased only marginally to 27.6 ng/ml, which means that growing-up milk does not lead to an excessive supply of vitamin D in summer. This first prospective, double-blind intervention study with growing-up milk in Europe showed that consuming growing-up milk with approx. 2.9 µg per 100 ml of vitamin D instead of low-fat cow's milk is a simple and safe way to prevent the drop in 25(OH)D serum concentration during the winter without increasing the 25(OH)D serum concentration to excessively high levels during the summer [36].

The cross-sectional study in 2013 used a 3-day diet record to investigate the diet and nutrient supply of 241 children who drank growing-up milk, and 206 children who did not drink growing-up milk but drank cow's milk or consumed other dairy products instead. Even though the protein and sodium intake in the growing-up milk group was lower than in the group that did not drink growing-up milk, these values were still above the quantities recommended by the EFSA. In all age groups, the children in the growing-up milk group were significantly better supplied with essential fatty acids, vitamins C, A, D and E and all B vitamins. This also applied to iron intake, which was significantly higher in the growing-up milk group than in the group which were not given any growing-up milk (Figure 1).

The intake of DHA and ARA was similar. To reach the quantities recommended by the EFSA, at least 360 ml growing-up milk was required. The authors conclude that growing-up milk can help children get their recommended amounts of nutrients. However, the quantities of protein, sodium and vitamin A were above the EFSA recommendations, and the quantities of DHA, ARA and vitamin D were below them (Figure 1 and 2). 37

## Conclusion

Early life malnutrition in terms of both macro and micronutrients can cause metabolic derangements which could impair or delay the physical and cognitive development of the individual. Deficiencies should be promptly identified to tailor interventional strategies specifically to the metabolic needs of the individual [38,39].

Nutritional biomarkers are useful for assessing nutrient intake, but they have limitations in terms of accuracy. Just combining anamnesis, clinical evaluation, growth, and dietary assessment, we can effectively identify and address potential micronutrient deficiencies in children during the first 1000 days of life. Overall, most micronutrient deficiencies can be prevented during the first 1000 days of life through nutrition guidance, food fortification, or supplementation. And the role of GUM over the fresh cow milk in terms of preventing micronutrients deficiencies specially Vit D, Iron, Omega 3 can be neglected and should be considered. Timely supplementation can provide a lifelong advantageous impact on child development. contributing to inadequate intake of micronutrients [40].



In conclusion, nutrition in the first 1000 days of life through correct, specific, and precise guidance could help prevent mainly nutrition deficiencies over time.

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