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LITERATURE REVIEW

The roles of growing up milk on growth and anemia prevention in children under 5 years of age

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Abstract

Background: Adequate nutrition during the early years of life is necessary for good growth, development, and long-term health outcomes. The first 1000 days of life are a critical time for nutrition.

Aims: This literature review aimed to evaluate the role of growing up milk on growth, stunting, and anemia prevention of under-five children.

Methodology: This study used a literature review approach, searching three databases: PubMed, Google Scholar, and Cochrane. The inclusion criteria in this literature review were 1) randomized clinical trials, systematic review, and meta-analysis, 2) studies conducted over the last 10 years, 3) available in full text, 4) written in Indonesian or English, and 5) Research studies conducted in humans.

Result: We identified 3 publications, that matched the inclusion criteria and research aims, including 2 original articles from Lovell AL, et al and Cervo MCM, et al, and 1 meta-analysis by Brooker PG et al. Fortified milk (GUM) consumption significantly had a positive impact on nutritional status, especially growth and hemoglobin status (anemia).

Conclusion: Fortified milk (GUM) consumption is a solution to macro-micronutrient adequacy in under five children. More efforts are needed to conduct studies in Indonesia on GUM and address specific nutrients that may promote linear growth, reverse stunting and anemia in children.

Keywords: growing up milk, growth, anemia

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Introduction

The period from a baby's conception to their second birthday, commonly known as the first 1000 days, plays a critical role in determining their future health. As a result, global health organizations like the World Health Organization (WHO) have developed guidelines aimed at promoting optimal nutrition for infants and young children during this crucial timeframe.[1]

At 12 months of age, it's important for them to consume a variety of nutritious solid foods adhere to dietary guidelines and provide the appropriate balance of nutrients.[2-4] However, compliance with dietary guidelines is known to be low in both higher- and lower-income countries, which places young children at risk of missing out on essential macro- and micro-nutrients during this critical developmental period.[5-6]

Early in life, proper nutrition is essential for the best possible growth, development, and long-term health results.[7] Unfortunately, a lot of kids, especially younger ones under five, don't get enough macro and micronutrients, which can cause stunting, growth failure, and an increased risk of infections and anemia.[8] Malnutrition is defined as an inadequate or unbalanced nutrient intake. If this condition persists, children under five years old are at risk for stunting and anemia.[9] Malnutrition has long-term effects on a child's growth and development during the first 1000 days of life.

The goal of this literature review is to examine how growing up milk affects the adequacy of macro-micronutrients and how it affects the growth, stunting, and prevention of anemia in children under five.

Methods

This literature review uses three databases, PubMed, Google Scholar, and Cochrane, with PICO as listed below:

P: under five children
I: growing up milk
C: none growing up milk
O: growth and development

The inclusion criteria in this literature review were 1) randomized clinical trials, systematic review and meta-analysis, 2) studies conducted over the last 10 years, 3) available in full text, 4) written in Indonesian or English, and 5) Research studies conducted in humans. Articles with a lack of available data were excluded. Keywords of "growing up milk", "fortified milk", "stunting", "anemia", and "under five children", were used—literature search process presented in **Figure 1**.

Results

We have found 3 publications, that matched our criteria and the aim of this literature review (**Table 1**). The articles were 2 original articles from Cervo MCM, et al.[10] and Lovell AL, et al.[11] Also, there was 1 meta-analysis from Brooker PG, et al.[12]

In their ten-week nutrient-fortified milk-based formula study, Cervo MCM et al.[10] found that preschoolers who drank two servings of fortified milk a day for twelve weeks had a significant increase in height (1.40 cm), weight (1.35 kg), body mass index (0.96 kg/m2), mid-upper arm circumference (0.66 cm), and psychomotor scores (13.74% higher) compared to those who did not drink fortified milk ($p < 0.0001$).[10] A long with that, Lovell et al.[11] RCT study comparing Cow Milk and Growing-Up Milk revealed that GUM enhances Vitamin D and Iron status in healthy 2-year-old children. Brooker et al.[12] meta-analysis on the impact of fortified formula on growth and nutritional status of young children demonstrate that fortified milk leads to increased weight gain (MD = 0.14 kg [95% CI 0.06, 0.21], p = 0.0003) compared to control milk. Results from subgroup analyses indicate improved weight gain in lower-income countries and in studies with intervention periods exceeding 6 months. However, no effects on other anthropometric measures were observed. Furthermore, infants consuming fortified milk exhibited increased hemoglobin (MD = 3.76 g/L [95% CI 0.17, 7.34], p = 0.04) and ferritin (MD = 0.01 nmol/L [95% CI 0.00, 0.02], p = 0.02) concentrations.[12]

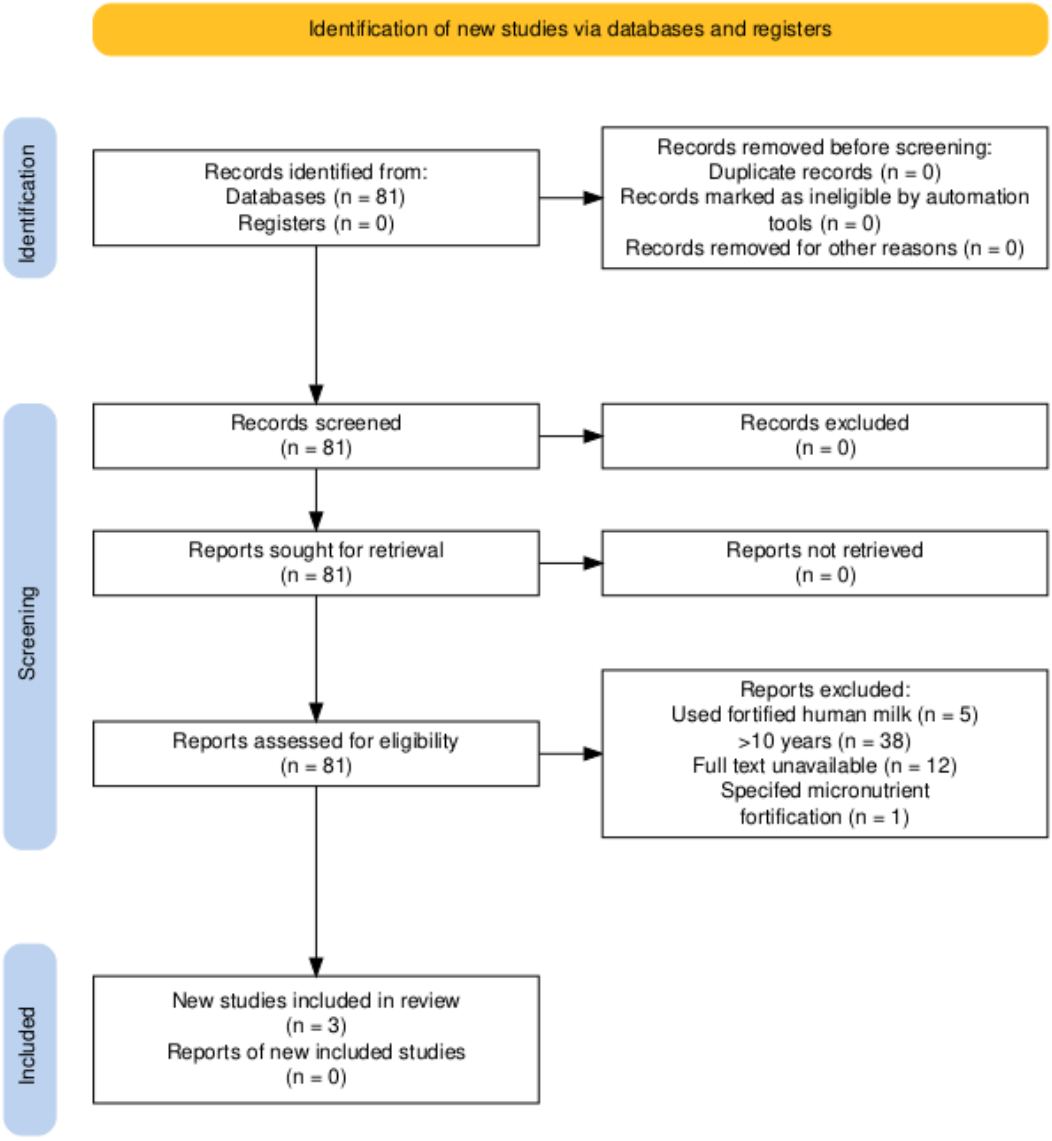

Figure 1. PRISMA flow chart for study selection

Table 1. Characteristics of included studies

No	Author	Title	Subjects	Intervention	Results
1.	Cervo MCM, et al	Effects of Nutrient-Fortified Milk Based Formula on the Nuritional Status and Psychomotor Skills of Preschool Children	One hundred twenty (120) preschools children, aged 3–5 years, with mean age of 4.10 ± 0.14 years were recruited for the study.	This randomized, single-masked, controlled trial examined the effects of nutrient-fortified milk-based formula supplementation on nutritional status, nutrient intake, and psychomotor skills. Study participants were divided equally into three major groups, normal, underweight, and severely underweight based on WHO-Child Growth Standards, and were further divided into two groups: fortified milk group who was given two glasses of fortified milk (50 g of powdered milk/serving) a day for twelve weeks in addition to their usual diet and the nonintervention group who was not given fortified milk and thus maintained their usual intake.	Results showed that consumption of two servings of fortified milk a day for twelve weeks significantly increased the height of preschool children by 1.40 cm, weight by 1.35 kg, body mass index by 0.96 kg/m2, mid-upper arm circumference by 0.66 cm, and psychomotor scores by 13.74% more than those children who did not consume fortified milk ($p < 0.0001$). Hence, fortified milk-based supplement in the diet of preschool children improved overall nutritional status, nutrient intake, and performance in psychomotor scale.

No	Author	Title	Subjects	Intervention	Results
2.	Lovell AL, et al	Compared with Cow Milk, a Growing-Up Milk Increases Vitamin D and Iron Status in Healthy Children at 2 Years of Age: The Growing-Up Milk-Lite (GumLi) Randomized Controlled Trial	160 healthy 1-y-old	Participants were randomly assigned 1:1 to receive GUMLi (1.7 mg Fe/100 mL; 1.3 μg cholecalciferol/100 mL) or CM (0.02 mg Fe/100 mL; 0.06 μg cholecalciferol/ 100 mL) for 12 mo.	GUMLi was a large contributor to dietary intakes of iron and vitamin D after 12 mo when compared with intakes from food and CM. The adjusted mean difference between groups for serum ferritin concentrations was 17.8 μg/L (95% CI: 13.6, 22.0 μg/L; P < 0.0001), and for 25(OH)D it was 16.6 nmol/L (95% CI: 9.9, 23.3 nmol/L; P < 0.0001). After 12 mo, ID was present in 16 (24%) participants in the CM group and 5 (7%) participants in the GUMLi group (P = 0.009), and the prevalence of VDD in the CM group increased to 14% (n = 10) and decreased to 3% (n = 2) (P = 0.03) in the GUMLi group.
3.	Brooker PG, et al	Effect of Fortified Formula on Growth and Nutritional Status in Young Children: A systematic Review and Meta-Analysis.	A total of 12 studies reported across 19 publications met the eligibility criteria and were included in the review	The systematic review and meta-analyses were conducted and reported in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement	Fortified milk was associated with increased weight gain (MD = 0.14 kg [95% CI 0.06, 021], p = 0.0003) compared with control milk. Subgroup analyses demonstrated increases in weight in lower-income countries, and in studies with intervention periods > 6 months. There were no effects of fortified milks on other anthropometric measures. Haemoglobin (MD = 3.76 g/L [95% CI 0.17, 7.34], p = 0.04) and ferritin (MD = 0.01 nmol/L [95% CI 0.00, 0.02], p = 0.02) concentrations were increased in infants consuming fortified milks.

Discussion

Even though the rate of malnutrition in Southeast Asia has decreased, it is expected that over 25% or 165 million children under the age of 5 around the world are suffering from stunted growth. This is particularly prevalent in Africa and Asia, with 90% of affected children residing in these regions. For children to grow and develop in a healthy way, nutrition is crucial. Malnutrition in children is still a serious issue in developing nations like Indonesia. Several research works have indicated a relationship between children's cognitive ability and growth factors such as height, weight, and head circumference. Inadequate nutrition has been found to lead to decreased academic performance, increased absenteeism, and lower intelligence. Nutrition also significantly impacts the development of cognitive and psychomotor skills, with iron being especially essential for neurotransmitter production and energy metabolism. Preschool-age children (those under five years old) are particularly susceptible to nutritional deficiencies during this time, especially after weaning. Although their need for calories remains high, young children may refuse to eat nutrient-rich foods due to picky eating habits or limited food options, making it difficult to ensure they receive the necessary nutrients for healthy growth and development. Thus, supplementing a child's usual diet with significant amounts of nutrients in the form of energy and nutrient-dense food could be quite beneficial.[10]

In the first two years of life, linear growth retardation can have significant consequences; these effects typically manifest during the supplementary feeding period. Lack of diversity in the diet and insufficient quantities of complementary foods have been linked to stunted growth in children. Dietary diversity is a crucial aspect of a healthy diet, and a more varied diet is strongly correlated with adequate intake of energy, protein, and micronutrients. Insufficient consumption of these vital nutrients over a prolonged period puts children at risk of stunted growth.[12,13] Due to their ability to regulate IGF-1 levels, macronutrient components like high-quality protein and necessary amino acids have been identified as critical components that support childhood growth. It has been demonstrated that children with low protein consumption have poor linear growth.[15] Furthermore, energy deficiency in these children can also result in suboptimal growth, loss of body fat, and muscle. Ensuring adequate intake of both macronutrients and micronutrients, such as iron, zinc, phosphorus, and vitamins, is crucial for proper growth.[14-20]

Anemia affects around 300 million preschool-aged children worldwide, with a significant prevalence among children in underdeveloped nations. Children's cognitive and physical development is negatively impacted by anemia, which can also have long-term effects on an adult's physical productivity and ability to reproduce. It is often believed that iron deficiency, primarily from inadequate dietary intake or lack of iron, accounts for roughly half of instances of anemia. [21-23]

According to studies conducted in Indonesia, the majority of children under five were unable to satisfy their daily needs for macro- and micronutrients. Research conducted in Sumbawa by Limardi et al. discovered that while 14% of children who were not stunted obtained appropriate supplemental dietary diversity, just 6% of stunted children did. Compared to the non-stunted group, the stunted group consumed much less flesh foods (beef, fish, poultry, organ meat, and other types of meat). Additionally, compared to children who are not stunted, the median consumption of total protein was considerably lower in stunted children.[24] A study by Semba et al. showed that kids between the ages of 6 and 59 months who drank iron-fortified milk had a lower risk of anemia than kids who didn't.[25] However, a meta-analysis by Matsuyama et al. on the impact of fortified milk on young children's growth and nutritional status discovered that, when compared to control milk, the effects of fortified milk on weight gain were negligible. When compared to control groups, the risk of anemia was lower in the fortified milk groups. There were no appreciable effects on changes in body composition, Hb concentration, or height gain that could have been impacted by the fortification type. When fortified milk is fully absorbed and combined with a regular diet, it can

serve as a useful supplemental nutrition source for children who may benefit from it.[26]

Growing-up milk (GUMs), also known as young-child formula (YCF), are milk-based beverages that supply nutrients for which there may occasionally be only a minimal intake during the early childhood dietary transition period.[26,27] Supplementation may offer substantial nutritional and energy benefits, thereby enhancing dietary adequacy. Milk has a lot of different nutrients. Additional nutrients found in the powdered fortified milk-based formula (GUM) include energy, protein, fat, carbohydrates, vitamin A, thiamine, riboflavin, niacin, vitamins B6, B12, C, D, E, and K, folic acid, pantothenic acid, biotin, calcium, phosphorus, chloride, iodine, iron, zinc, manganese, copper, choline, dietary fiber, and linoleic acid. These nutrients are all essential for a child's growth and development, as controlled by CODEX.[10]

Lovell et al.[11] research revealed that when given to 12-month-old children as a complete meal, GUM maintains iron stores and considerably lowers the occurrence of iron insufficiency as compared to CM consumption at two years of age. The results of the study were also observed, showing that GUM considerably increased total iron intakes, suggesting that supplying a fortified diet by consumption of ≥300 mL GUMLi/d was a suitable approach. These results suggest that GUM may be utilized as a tactic to raise dietary iron levels and lower the incidence of ID anemia. Cervo MMC, et al[10] Research indicates that giving three to five-year-old children an oral nutrition supplement consisting of two servings of a fortified milk-based formula for a duration of twelve weeks is linked to enhancements in certain anthropometric metrics and psychomotor abilities. It is clear that all groups that drank fortified milk-based formula were able to meet and even surpass the standard or expected average gain in height and weight for a preschooler, compared to the non-intervention group, which only increased in height within the expected range and did not even meet the standard or average weight gain for a preschooler. The group that had fortified milk had higher energy and nutritional consumption. The nutrients included in the milk included carbs, protein, lipids, calcium, phosphorus, magnesium, zinc, copper, and vitamins C, D, and K. The recommended energy and nutrition intake (RENI) and estimated average requirement (EAR) for all essential nutrients—energy, protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin, and vitamin C—were met by the participants who drank fortified milk. Therefore, adding fortified milk-based formula to preschoolers' diets may assist to enhance their overall nutritional status as well as their psychomotor skills, which are essential for meeting developmental milestones. These two RCTs were consistent with a meta-analysis conducted by Brooker PG et al.[12] which discovered that drinking fortified milk may help young children's growth and nutritional status in certain areas, especially in study groups where undernutrition was a concern. It is important to note, however, that there is a wide range of these products available, with variable compositions, therefore, it is important to consult with a qualified healthcare provider when choosing the most suitable product

Cross sectional studies in Indonesia showed a positive impact of GUM on nutritional status. Unpublished data of Sasmiati et al, in Yogyakarta, found that there was correlation between formula milk consumption and under-five children nutritional status.[28] And a cross-sectional study from Sjarif DR et al showed that two protein sources had a significant association with stunting, namely, GUM as a protective factor. This result shows that a GUM consumption of 300 ml/day is associated with less stunting.[29]

The present literature review found that consuming GUM can improve nutritional status, including iron in young children. Considering that iron deficiency is the most common nutrient deficiency among children in the world, it is an important public health concern to be addressed. Especially, when adequate nutritious complementary foods are unavailable or fussy eating behaviour is prevalent during dietary transition, children may not be meeting nutritional requirements for optimal growth and development. Under such circumstances, fortified milk (GUM) may be a safe, acceptable, and effective source of nutrients to supplement those children in need, to

provide essential nutrients to these children in need, until they can establish healthier eating habits.

This paper has both strengths and limitations. One strength is that the authors independently screened articles and extracted data from all the included papers. Results were discussed at a designated time between all authors, and a consensus was reached regarding each paper. However, there are some limitations to this review. The only search engines utilized for this literature evaluation were PubMed, Google Scholar, and the Cochrane database; hence, not all pertinent papers in Indonesian may have been found. Furthermore, the analysis was restricted to research papers released between 2014 and 2024; a larger time range would have produced additional or different findings.

Conclusion

Fortified milk (GUM) consumption had a significant positive impact on nutritional status, especially growth and hemoglobin status (anemia). Fortified milk (GUM) consumption is a solution to macro-micronutrient adequacy in under five children. More efforts are needed to conduct studies in Indonesia on GUM and address specific nutrients that may promote linear growth, reverse stunting anemia in children.

Conflict of interest

The authors declare there is no conflict of interest regarding this article.

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