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PROBIOTICS ROLE ON IMPROVING MALNUTRITION IN BOTH UNDER- AND OVERWEIGHT CHILDREN: A NARRATIVE REVIEW

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Abstract

Background: Malnutrition in children exists at both ends of the spectrum, undernutrition and overnutrition, each with significant health consequences. Probiotics, live microorganisms that confer health benefits when administered in adequate amounts, are being explored as potential interventions through their ability to modulate gut microbiota, enhance nutrient absorption, and regulate immune function. **Methods**: A narrative review of literatures published between 2004 and 2025 was conducted, covering randomized trials, meta-analyses, and reviews involving probiotics interventions in children. Seventeen key studies were categorized by nutritional status (undernutrition and overnutrition), pediatric health outcomes, and nutritional insights. These studies synthesized and cited into this scientific narration. **Results:** In undernourished children, probiotics improved weight gain, reduced anemia, enhanced immune responses, and lowered respiratory infection incidence, particularly in low-resource settings. In overweight/obese children, certain *Lactobacillus* and *Bifidobacterium* strains improved BMI z-scores and metabolic health. Broader pediatric data support condition-specific benefits of probiotics in gastrointestinal and allergic diseases. Mechanistic evidence highlights bioactive molecules, immune modulation, micronutrient bioavailability, and gut barrier integrity as key pathways. **Conclusions:** Probiotics have context-specific benefits for pediatric malnutrition, with the strongest evidence in infection reduction and modest growth improvement in undernourished populations. Their role in pediatric obesity is promising but less defined. Strain specificity, dose, and duration remain critical determinants of efficacy, and further high-quality trials are needed.

Keywords: Probiotics, pediatric malnutrition, undernutrition, obesity, gut microbiota

Introduction

Malnutrition in children encompasses both undernutrition (including underweight, stunting, and wasting) and overnutrition (overweight and obesity). Despite presenting with contrasting anthropometric outcomes, these conditions share certain pathophysiological features, particularly disruptions in the gut microbiota–gut barrier–immune system axis. This shared pathway provides a rationale for exploring probiotics as a potential adjunct therapy across the malnutrition spectrum.[1, 2]

At the undernutrition end, insufficient dietary intake, recurrent infections, and impaired nutrient absorption contribute to poor growth and developmental delays. At the overnutrition end, excess energy intake, metabolic dysregulation, and chronic low-grade inflammation drive weight gain and its associated comorbidities. It is linked to impaired growth, increased infection susceptibility, and delayed neurodevelopment, while overnutrition is associated with metabolic syndrome, type 2 diabetes, and cardiovascular disease.[3, 4]

Probiotics are “live microorganisms which, when administered in adequate amounts, confer a health benefit on the host” that function through strain-specific mechanisms such as modulation of gut microbiota, enhancement of intestinal barrier function, competitive pathogen inhibition, and immune regulation.[5, 6, 7] On the side notes, there are prebiotics that are non-digestible food components (e.g., inulin, fructooligosaccharides) that selectively promote the growth of beneficial bacteria.[5, 8] There are also synbiotics combine probiotics and prebiotics to enhance probiotic survival and colonisation.[8]

Given the gut microbiota’s role in nutrient absorption, immune function, and metabolic

homeostasis, probiotics are increasingly being studied as interventions for both under and overnutrition in children. This review synthesizes recent clinical and mechanistic evidence on probiotics' role in improving nutritional and health outcomes in these populations. [6, 9]

Method

Literature review was conducted by comprehensive searching databases on PubMed, Scopus, and Google Scholar, for studies published from January 2004 to February 2025. Keywords included "probiotics," "children," "malnutrition," "undernutrition," "obesity," "synbiotics," and "gut microbiota."

The inclusion criteria are as following:

1. Pediatric populations (0–18 years).
2. Intervention with probiotics
3. Outcomes on nutritional status, as well as growth, infection, immune function, and metabolic markers

A total of 17 core studies (randomized controlled trials, systematic reviews/meta-analyses, and narrative reviews) met the criteria and were synthesized in the Results and Discussion. An additional five references were cited for background information, definitions, and contextual framing (e.g., WHO/FAO guidelines, epidemiology data).

Results

Probiotics' benefit for undernourished children

Growth and development

Probiotics improved weight gain in several studies, especially in low-resource settings It was also found that synbiotic-fortified milk improved growth Z-scores in some trials. Effects on growth were more notable in developing country settings and when fortification included Iron, Vitamin C, and probiotics and/or synbiotics.[9, 10, 11, 12]

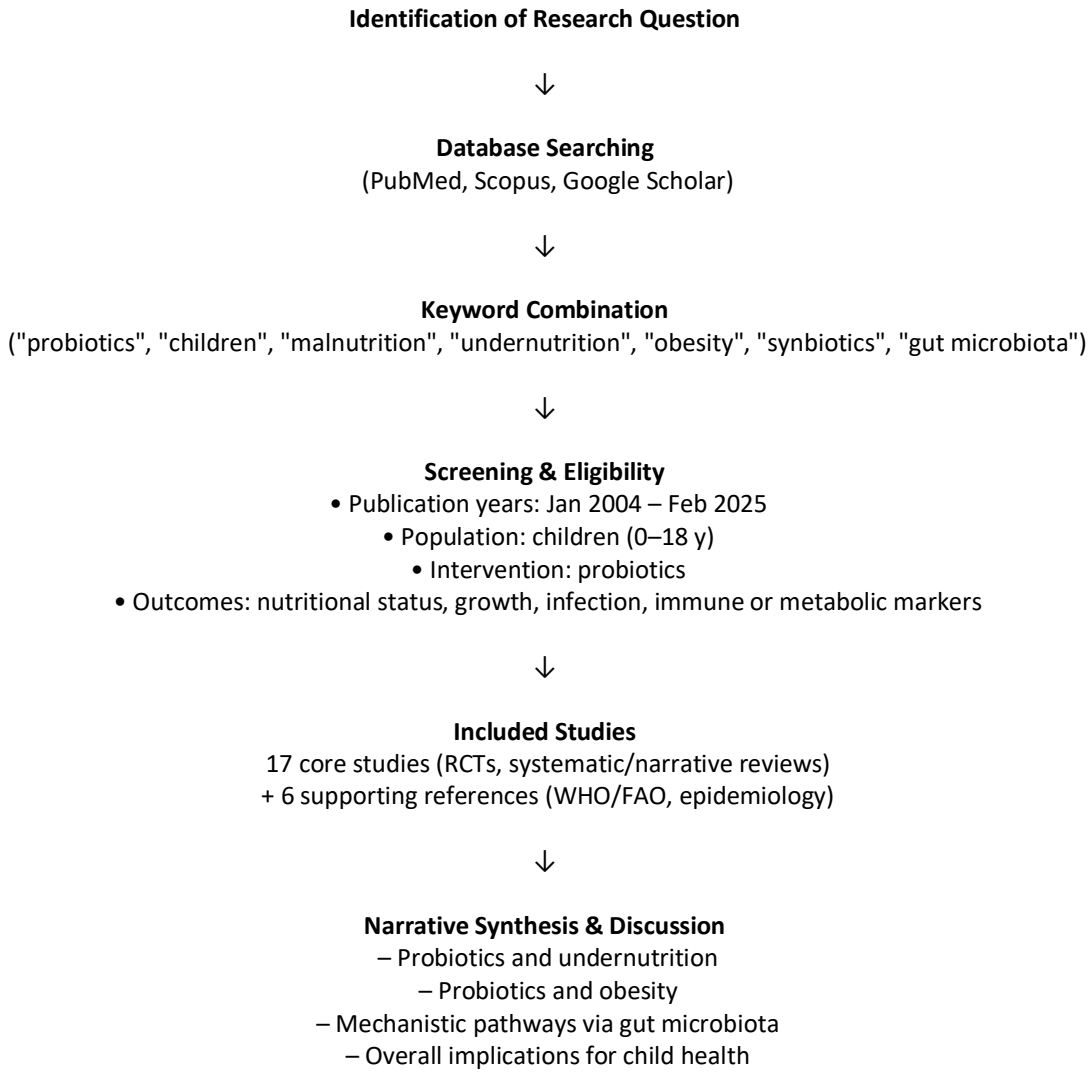

Figure 1. Flow diagram of the literature search and synthesis process

This meta-analysis shows that fortified milk, including probiotic or synbiotic-enriched formulations, can produce small but meaningful improvements in weight gain and substantially reduce anemia risk in healthy children aged 6–47 months. The variability in formulation, duration, and study settings limits generalizability, underscoring the need for further trials before universal recommendations can be made.[12]

Immune enhancement and Infection Reduction

Malnutrition; both undernutrition and overnutrition, adversely affects children's immune systems, heightening their vulnerability to infections. Targeted nutritional interventions, including micronutrients, protein supplementation, and probiotics, can reverse some of these impairments as well as restore immune function and reduce infection severity.[7]

The human gut is a host of vary microorganisms, start at the beginning of birth and continuing through early childhood phase. Mainly influenced by various factors such as mode of delivery, dietary pattern (breastfeeding and solid foods), and gestational age, among other factors. The gut microbiota plays critical roles including metabolic functions, such as nutrient breakdown, pathogen prevention, and immune system.[13]

Probiotic strains such as Lactobacillus casei and Lactobacillus acidophilus have shown the ability to improve immune responses in malnourished children by enhancing macrophage activity, cytokine secretion, and immune cell counts. The integration of probiotics into broader nutrition and infection control programs may strengthen recovery and long-term immune health.[7]

Probiotics and/or synbiotics supplementation reduced lower respiratory tract infections (LRTI) and otitis media incidence. No significant and consistent effects found on URTIs, GI

infections, or diarrhea incidence in overall.[14] These findings suggest a role for targeted probiotic/synbiotic strategies as adjuncts to standard nutrition programs in high-risk pediatric populations.

Delivery vehicles

Locally acceptable formats (e.g., biscuits[11], yogurt[9]) achieved high compliance. The observed benefits are likely mediated by improved nutrient absorption and gut microbiota modulation through *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Given its low cost, ease of integration into school programs, and cultural acceptability, probiotic yogurt represents a scalable nutritional intervention for malnutrition in early childhood education settings.

Fortified food as the functional food vehicles are culturally acceptable, safe, and feasible for community-level nutrition interventions. Sustained consumption over 90 days led to stable adherence and no reported adverse effects, are also indicating practical scalability.[9, 11]

Probiotics in overweight and obese children

The potential of probiotics in preventing and managing pediatric obesity is promising, emphasizing gut microbiota modulation as a therapeutic target. Gut microbiota imbalance is increasingly recognized as a driver of pediatric obesity, and probiotic supplementation offers a non-pharmacological means to restore microbial homeostasis. Certain *Lactobacillus* and *Bifidobacterium* strains reduced BMI z-scores and improved metabolic markers in obese children.[15]

In addition, synbiotics may offer synergistic benefits by enhancing probiotic colonization. This shows that pairing probiotics with prebiotics (synbiotics) may enhance efficacy and optimize colonization which leads to therapeutic impact, but evidence in children is still limited. However, the results vary by strain, dose, and study duration, and more RCTs in pediatric populations are needed.[15, 16]

Strain-specific benefits

In addition, vary evidences and recommendations of probiotics and prebiotics in pediatric populations are found, focusing on strain-specific benefits and clinical indications. Certain probiotics strains (e.g., *Lactobacillus rhamnosus* GG, *Saccharomyces boulardii*) have demonstrated efficacy in preventing or treating acute infectious diarrhea, antibiotic-associated diarrhea, and necrotizing enterocolitis in preterm infants.[17] In the other hands, in chronic pediatric infection bowel diseases, high-dose probiotics (e.g., VSL#3) may benefit ulcerative colitis but have limited evidence in Crohn's disease.[16]

Probiotics in healthy children generally have minimal growth effect unless targeting specific deficiencies or conditions.[6] However, the specific-condition benefits as mentioned above, might be helpful to sustain and improve growth. The mechanisms by which probiotics exert clinical benefits in pediatric populations include modulation of the gut microbiota, enhancement of intestinal barrier function, and modulation of systemic immune responses, while prebiotics act as substrates that selectively stimulate beneficial bacterial growth. The evidence base is highly strain-specific; thus, outcomes observed with one strain cannot be generalized to others, and factors such as dose, duration, and host characteristics significantly

influence the observed effects. Probiotic efficacy in children depends strongly on strain, dosage, combination, and clinical indication.[6, 17]

Enhancing micronutrient absorption

Across 14 heterogeneous trials, certain probiotics were associated with improved status or absorption of Vitamin B12, Folate, Iron, Calcium, and Zinc, but results varied widely by strain, dose, duration, and delivery; overall certainty is limited.[18]

The review indicates that certain probiotic strains can enhance status or bioavailability of micronutrients in healthy individuals, but the evidence base is heterogeneous, making it difficult to generalize across strains or to define optimal dosing. Translating these benefits to pediatric malnutrition should be done cautiously and ideally within targeted, strain-specific interventions.[18]

Barrier function and inflammation

Probiotics support gut integrity, reduce permeability, and modulate inflammatory pathways. Bioactive molecules from probiotics contribute to gut microbiota modulation, pathogen inhibition, anti-inflammatory effects, and metabolic regulation in children. These molecular mechanisms underpin observed clinical benefits in reducing gastrointestinal infections, supporting immune development, and potentially modulating obesity-related outcomes. [7, 19, 20]

Anti-inflammatory effects may help mitigate chronic low-grade inflammation seen in obesity and other pediatric conditions. For clinical application, probiotic strain selection

should prioritize those with the capacity to produce bioactive molecules that align with the intended therapeutic goals.

Discussion

The compiled evidence demonstrates that probiotics can be a valuable adjunct in addressing both undernutrition and overnutrition in pediatric populations, although benefits are highly strain-, dose-, and context-dependent.

Probiotics have greater impact in undernourished pediatric populations, particularly in resource-limited settings where diarrheal disease burden and micronutrient deficiencies are high.[7, 9, 10, 11, 12, 14] These effects include modest weight gain, improved nutrients intake, and enhanced immune response. In undernourished children, improvements in growth outcomes have been consistently observed in settings with high infectious disease burden and low baseline nutritional status.[2, 3, 10] The delivery of probiotics through culturally acceptable food vehicles such as fortified biscuits and probiotic yogurt has been shown to improve adherence and feasibility for large-scale implementation.[3, 10]

In overnutrition children, probiotics can influence body composition and metabolic markers, though evidence is still emerging.[15] Moreover, probiotics may modulate gut microbiota composition, reduce low-grade inflammation, and improve metabolic profiles.[6] Synbiotics appear promising but require more pediatric trials before widespread recommendation.

While findings are encouraging, heterogeneity in study design, populations, probiotic strains, and delivery formats limits in general. Overall, the synthesis supports the selective,

evidence-based integration of probiotics into pediatric nutrition strategies, tailored to the target population and health context.[20] However, further high-quality randomized controlled trials are required to determine optimal strain combinations, dosages, and delivery methods, as well as to assess long-term safety and cost-effectiveness.[6, 17]

Gut microbiota composition in individuals is influenced by numerous factors, including maternal health, mode of delivery, infant feeding practices, antibiotic exposure, and environmental influences. An optimal microbiota balance contributes to overall health and immune resilience, while disruption of this balance—known as dysbiosis—has been implicated in the development of various diseases such as inflammatory bowel disease, asthma, allergies, obesity, and other metabolic disorders. Furthermore, the microbiota–gut–brain axis underscores the essential role of a healthy gut ecosystem in neurodevelopment, linking microbiome alterations to neurocognitive outcomes. [20, 22]

Intervention targeting the gut microbiota through supplementation with probiotics and/or prebiotics offers a promising approach to restoring microbial balance. Probiotics have been shown to enhance nutrient absorption, immune modulation, and metabolic regulation, while prebiotics may provide synergistic benefits through selective stimulation of beneficial bacterial growth. Emerging evidence suggests that prebiotic and probiotic administration can confer benefits in immune-mediated diseases, obesity, and allergic conditions, though further studies are needed to elucidate mechanisms and optimize intervention strategies.[21, 22,23]

Conclusion

Probiotics can be valuable adjuncts to nutritional interventions for pediatric

malnutrition to address both undernutrition and overnutrition, with benefits in growth, immune function, and infection prevention in undernourished populations, and potential metabolic benefits in overweight children. Their use should be guided by strain-specific evidence and integrated into comprehensive nutrition programs. While the preliminary evidence is encouraging; robust and context-specific research are highly needed to inform clinical and policy recommendations.

References

1. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013;382(9890):427-451. doi:10.1016/S0140-6736(13)60937-X.
2. WHO. Malnutrition. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/malnutrition
3. Sahoo K, Sahoo B, Choudhury AK, Sofi NY, Kumar R, Bhadoria AS. Childhood obesity: causes and consequences. *J Family Med Prim Care*. 2015;4(2):187-192. doi:10.4103/2249-4863.154628.
4. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes*. 2011;35(7):891-898. doi:10.1038/ijo.2010.222.
5. FAO/WHO. Health and nutritional properties of probiotics in food including powder milk with live lactic acid bacteria. Rome: FAO/WHO; 2001.
6. Thomas DW, Greer FR, American Academy of Pediatrics Committee on Nutrition,

American Academy of Pediatrics Section on Gastroenterology, Hepatology, and Nutrition. Probiotics and prebiotics in pediatrics. *Pediatrics*. 2021;147(6):e2021051485. doi:10.1542/peds.2021-051485.

7. Morales F, Montserrat-de la Paz S, Leon MJ, Rivero-Pino F. Effects of malnutrition on the immune system and infection and the role of nutritional strategies regarding improvements in children's health status: a literature review. *Nutrients*. 2024;16(1):1. doi:10.3390/nu16010001.
8. Gibson GR, Hutkins R, Sanders ME, Prescott SL, Reimer RA, Salminen SJ, et al. Expert consensus document: The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics. *Nat Rev Gastroenterol Hepatol*. 2017;14(8):491-502. doi:10.1038/nrgastro.2017.75.
9. Faradisa RR, Retnaningsih R, Alfitri R. The impact of probiotic yogurt supplementation on weight gain among preschool children: Evidence from an early childhood education setting in Indonesia. *J Bimbingan Konseling Terapan*. 2025;9(2):217-226. doi:10.30598/bkt.v9i2.19677.
10. Onubi OJ, Poobalan AS, Dineen B, Marais D, McNeill G. Effects of probiotics on child growth: a systematic review. *J Health Popul Nutr*. 2015;34:8. doi:10.1186/s41043-015-0010-4.
11. Adi AC, Kusharto CM, Marliyati SA. The effect of probiotic biscuit on faecal microbiota in malnourished children. *Sains Malaysiana*. 2022;51(12):4185-4195. doi:10.17576/jsm-2022-5112-25.
12. Matsuyama M, Harb T, David M, Davies PSW, Hill RJ. Effect of fortified milk on growth and

nutritional status in young children: a systematic review and meta-analysis. *Public Health Nutr*. 2017;20(7):1214-1225. doi:10.1017/S1368980016003189.

13. Kartjito MS, Yosia M, Wasito E, Soloan G, Agussalim AF, Basrowi RW. Defining the relationship of gut microbiota, immunity, and cognition in early life—A narrative review. Nutrients. 2023;15(12):2642. doi:10.3390/nu15122642.
14. Paiandeh M, Jafari-Vayghan H, Hashemi R, Jafari-Vayghan V, Mirghafourvand M, Ghavami A, et al. The effect of probiotic, prebiotic, and synbiotic supplements on anthropometric measures and respiratory infections in malnourished children: A systematic review and meta-analysis. *BMC Pediatr*. 2024;24:702. doi:10.1186/s12887-024-05179-y.
15. Balás RB, Molnár D, Decsi T, Kennedy K, Martin CR, Péter S, et al. Prebiotics, probiotics, and synbiotics: A research hotspot for pediatric obesity. *Nutrients*. 2023;15(13):2973. doi:10.3390/nu15132973.
16. Quak SH. Role of probiotics and nutrition in the management of chronic inflammatory bowel disease in children. *Singapore Med J*. 2013;54(4):183-184. doi:10.11622/smedj.2013069.
17. Schneider R, Sant'Anna A. Using probiotics in paediatric populations. *Paediatr Child Health*. 2022;27(8):482-491. doi:10.1093/pch/pxac087.
18. Barkhidarian B, Roldos L, Iskandar MM, Saedisomeolia A, Kubow S. Probiotic supplementation and micronutrient status in healthy subjects: a systematic review of clinical trials. *Nutrients*. 2021;13(9):3001. doi:10.3390/nu13093001.
19. Linda A, Rahmawati N, Dewi IA, Putri YD, Nugraheni AY, Wijayanti R, et al. The impact of bioactive molecules from probiotics on child health: A comprehensive review. *J Funct*

Foods. 2024;112:105028. doi:10.1016/j.jff.2024.105028.

20. Nawaz A, Nazir MI, Suleria HAR, Farooq F, Ayoub M, Baloch MH, et al. Nutritional and health potential of probiotics: A review. *Appl Food Res*. 2021;1(2):100016. doi:10.1016/j.afres.2021.100016.
21. Pasiak TF, Wiguna T, Sekartini R, Surapsari J, Sundjaya T, Wasito E, et al. The narrative review of recent studies in understanding the relationship between gut (microbiota)-brain axis, nutrition and cognitive function. *World Nutr J*. 2023;6(S2):30–40.
22. Kadim M, Masita BM. The importance of gut health in early life for long-term health. *World Nutr J*. 2022;5(S2):1–8. doi:10.25220/wnj.v05.s2.0001.
23. Sundjaya T, Djuwita R, Adisasmita AC, Tanjung C, Massi N, Fikri B, et al. Gut microbiome changes among undernutrition and stunting infants and children under 2 years: A scoping review. *Open Public Health J*. 2024;17(1). doi:10.2174/1874944502417010001.