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A NARRATIVE REVIEW ON THE PROTECTIVE MECHANISM OF PROBIOTICS TO COMMUNICABLE DISEASES AMONG CHILDREN IN ASIA

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Abstract

Background: Communicable diseases remain a major cause of morbidity among children in Southeast Asia, where malnutrition, environmental enteric dysfunction, and limited sanitation increase susceptibility to infection. Probiotics have gained attention as a nutrition-based strategy capable of improving gut health, enhancing immunity, and reducing pathogen burden. This narrative review summarizes the protective mechanisms of probiotics and their relevance for child health in Indonesia and neighboring countries. **Methods:** A comprehensive literature search was conducted in PubMed, Scopus, and Google Scholar for studies published from January 2004 to February 2025. Search terms included “probiotics,” “children,” “communicable diseases,” “gut microbiota,” “malnutrition,” and “synbiotics.” Inclusion criteria were: pediatric populations (0–18 years), probiotic interventions, and outcomes related to infection, intestinal integrity, immune function, or nutritional status. Fourteen core studies (RCTs, systematic reviews, meta-analyses, and narrative reviews) met criteria, and five additional sources were used for epidemiological and conceptual background. **Results:** Evidence across Indonesia, Vietnam, Malaysia, China, India, and Thailand shows that probiotics improve gut microbiota diversity, reduce pathogenic colonization, strengthen tight-junction expression, and enhance mucosal immunity. Clinical benefits include reduced incidence and duration of diarrhea and respiratory infections, improved recovery reflected in increased appetite and weight gain, reduced antibiotic prescriptions, and decreased school absenteeism. Probiotics were feasibly delivered through fortified milk, yogurt, supplements, and school-based nutrition platforms, aligning well with existing child-health programs. **Conclusion:** Probiotics offer a safe, nutrition-focused intervention that helps mitigate the infection–malnutrition cycle in children. By supporting gut integrity and immune maturation,

probiotics complement established nutrition strategies. Integrating probiotics into routine child nutrition and infectious-disease prevention programs may provide meaningful public health benefits, though long-term and multi-strain studies are needed to guide scalable implementation.

Keywords: Probiotics; Children; Communicable Diseases; Gut Microbiota; Nutrition; Southeast Asia

Introduction

Communicable diseases such as diarrhea and respiratory tract infections remain significant public health burdens among children in low- and middle-income countries, including Indonesia. According to the Indonesia Basic Health Research (Riskesdas), diarrhea accounts for one of the top causes of morbidity in children under five, with periodic spikes following monsoon seasons and sanitation challenges.[1] Similarly, acute respiratory infections (ARI) contribute to school absenteeism, nutritional parameters decline, and increased parental healthcare expenditure.[2] These patterns highlight the urgent needs for nutrition-sensitive strategies to strengthen pediatric immunity.

Early-life nutrition plays a critical role in shaping the gut microbiota, which functions as a key regulator of immune system development. Breast milk that rich in Human Milk Oligosaccharides (HMOs), *Bifidobacterium*, and other bioactive components create a microbiome profile that optimizes protection against pathogens.[3] However, rapid urbanization, dietary transitions, antibiotic misuse, and exposure to ultra-processed foods interrupt this natural process, promoting dysbiosis in Asian populations.[4] Probiotics offer a nutrition-based alternative to restore microbial balance and enhance host immunity strength.

Several clinical studies from Indonesia and the broader Asian region demonstrate the benefits of probiotics in preventing childhood infections. Vary randomized trials in Indonesia have shown that *Lactobacillus reuteri* supplementation reduces diarrhea episodes and improves microbiota composition among toddlers.[5] In Vietnam, *Lactobacillus acidophilus* and *Bifidobacterium bifidum* reduced acute respiratory infections in kindergarten children.[6] Similar results were observed in Thailand and Malaysia, where probiotic-enriched milk improved immunity and lowered infection rates.[7, 8]

Given the strong biological plausibility and growing regional evidence, evaluating the protective mechanisms of probiotics from a nutritional standpoint is crucial. This paper synthesizes mechanistic and clinical evidence to explain how probiotics protect children from communicable diseases through gut microbiome modulation, enhanced barrier function, immune system regulation, and metabolism-related effects.

Method

This narrative review was conducted through a comprehensive literature search across three major scholarly databases: PubMed, Scopus, and Google Scholar. The search covered studies published between January 2004 and February 2025, reflecting two decades of scientific advancement in probiotic research related to pediatric health and probiotics from nutrition point of view.

A combination of Medical Subject Headings (MeSH) and free-text keywords was used to ensure broad coverage of relevant publications. The primary search terms included: *"probiotics," "children," "pediatric," "communicable diseases," "infection,"*

"immune function," "gut microbiota," "synbiotics," and "nutrition." Boolean operators (AND/OR) and truncation symbols were applied to refine the search and capture variations in terminology.

The inclusion criterias are as following:

1. Population: Pediatric subjects aged 0–18 years, across clinical, community, or experimental settings.
2. Intervention: Administration of probiotic strains (single or multi-strain), with or without synbiotics.
3. Outcomes: Reported effects on at least one of the following domains; Communicable disease incidence or severity, immune response or inflammatory markers, gut microbiota composition, nutritional status (undernutrition, normal growth, or obesity), and metabolic or anthropometric indicators.

Titles, abstracts, and full-text articles were screened independently for relevance. A total of 37 studies met all inclusion criteria. These comprised randomized controlled trials (RCTs), systematic reviews and meta-analyses, and previous narrative reviews focusing on pediatric probiotic interventions. These studies were synthesized narratively in the Results and Discussion sections, emphasizing mechanistic insights, clinical relevance, and consistency of findings across contexts.

An additional five supporting references were incorporated to enhance background framing. These included sources such as WHO/FAO technical guidelines, epidemiological data on childhood communicable diseases, and foundational texts on gut microbiota and immune

modulation. These references did not contribute to primary data synthesis but supported contextual understanding and mechanism explanations.

Results

Nutrition and the Southeast Asian Pediatric Gut Ecosystem

Children in Southeast Asia including Indonesia, experience a double burden of malnutrition and infection, where deficits in macro- and micronutrient intake coexist with high exposure to communicable diseases. Protein–energy malnutrition, iron deficiency anemia, and zinc deficiency remain highly prevalent in Indonesian children, impairing epithelial integrity, reducing mucosal immunity, and increasing susceptibility to enteric and respiratory infections.[9]

Dietary patterns contribute substantially to this vulnerability. Many Indonesian children consume low dietary fiber, limited fruits and vegetables, and insufficient traditional fermented foods (e.g., tempeh, tape, dadih).[10] These patterns result in reduced microbial diversity, diminished short-chain fatty acid (SCFA) production, and weaker colonization resistance. Within this nutritional context, probiotic interventions that delivered through fermented milk, yogurt, fortified beverages, or supplements have shown potential to restore microbial balance, strengthen the intestinal barrier, and reduce infection burden.

Gut Microbiota Modulation: Evidence from Asian Pediatric Populations

The pediatric gut microbiome in Asia reflects unique dietary and cultural feeding habits, including higher rice intake, lower dairy consumption, and variable exposure to fermented foods. These factors shape microbiota signatures distinct from Western populations. Probiotic

interventions in Asian children consistently demonstrate improvements in beneficial bacterial abundance, microbial diversity, and pathogen suppression:

- Indonesia: Regular consumption of fermented milk containing *Lactobacillus casei Shirota* significantly reduced gastrointestinal infection rates among primary school children.[11]
- India: Supplementation with *Lactobacillus plantarum* and *Bifidobacterium lactis* improved gut microbial diversity and reduced diarrhea episodes among preschool-aged children.[12]
- China: *Bifidobacterium lactis* HN019 enhanced colonization of beneficial microbes and decreased enteric pathogen presence in young children.[13]

These findings reinforce the conceptual framework, particularly the mechanism of competitive exclusion, whereby probiotic strains inhibit pathogen adhesion, outcompete harmful microbes, and promote SCFA-mediated gut resilience.

Intestinal Barrier Function: Clinical and Nutritional Relevance

The integrity of the intestinal barrier is central to preventing pathogen translocation and subsequent infection. In Southeast Asian children, particularly in low- and middle-income settings, this barrier is frequently compromised due to micronutrient deficiencies, recurrent diarrheal illnesses, environmental enteric dysfunction (EED), and inadequate sanitation. Deficiencies in zinc, vitamin A, iron, and even protein intake have been shown to reduce epithelial regeneration, weaken tight junctions, and increase mucosal permeability.[14, 15, 16, 17] These nutritional deficits heighten susceptibility to pathogens, amplify inflammatory responses, and contribute to the cycle of malnutrition and infection.

Probiotics contribute to intestinal barrier restoration through multiple mechanisms. They enhance expression of tight junction proteins (e.g., occludin, claudins), increase mucin (MUC2) secretion, stimulate goblet cell activity, and promote epithelial repair through short-chain fatty acid (SCFA) production especially butyrate, which fuels colonocyte metabolism.[18, 19, 20, 21]

Evidence from Asian pediatric populations increasingly support these pathways:

- RCT demonstrated that *Lactobacillus rhamnosus* GG supplementation significantly upregulated tight junction protein expression and lowered fecal calprotectin levels among Thai children with recurrent diarrhea, suggesting reduced gut inflammation and improved epithelial integrity.[22]
- In Indonesia, probiotic-enriched yogurt administered to malnourished toddlers improved biomarkers of gut permeability such as decreased lactulose indicating enhanced mucosal barrier function and nutrient absorption.[23]
- Studies in other Asian contexts show improved stool consistency, fewer episodes of watery stools, and faster mucosal recovery following enteric infections.

Collectively, these findings affirm that probiotics play a therapeutic role in reinforcing intestinal barrier function, especially in nutritionally vulnerable children to help preventing pathogen entry and reducing both gastrointestinal and systemic infections.

Immune Modulation in Asian Children

Children in Southeast Asia are frequently exposed to respiratory and enteric pathogens due to dense living conditions, inadequate sanitation, and variable immunization coverage. Immune systems in early life are still maturing, and nutrition-related factors such as

deficiencies in protein, zinc, vitamin D, and essential fatty acids, which further impair immune competence. Probiotics can support this maturation by targeting multiple components of both innate and adaptive immunity.[6, 24, 25]

Mechanistically, probiotics enhance immunity through:

- Stimulating dendritic cell activation
- Promoting Th1/Th2 balance
- Increasing secretory IgA (sIgA) production
- Enhancing natural killer (NK) cell activity
- Modulating pro- and anti-inflammatory cytokine release

Regional evidence is particularly strongly explain similar result. In Malaysia, supplementation with *L. casei* Shirota increased salivary sIgA levels and reduced the frequency and duration of upper respiratory tract infections (URTIs), suggesting enhanced mucosal immunity.[24] Also found in Vietnam that probiotic formulations improved Th1/Th2 balance, resulting in fewer viral respiratory symptoms and reduced school absenteeism.[6] This shift is crucial in reducing hyperinflammatory responses and promoting effective viral clearance.

Study in Japan also resulting children receiving *L. gasseri* and *B. longum* exhibited higher systemic IgA responses and significantly fewer lower respiratory tract infections—highlighting probiotic effects on adaptive immunity.[25] In addition, complementary evidence suggests that probiotics and specific gut microbiota profiles may enhance vaccine immunogenicity. Systematic reviews report that probiotic supplementation can positively influence humoral responses to a variety of vaccines in humans, potentially improving seroconversion and antibody titers.[26] Prospective studies in infants have demonstrated trends toward improved

seroprotective responses following probiotic use, and recent research from Chinese cohorts links the abundance of *Bifidobacterium adolescentis* to stronger SARS-CoV-2 vaccine antibody responses, further highlighting the role of the microbiome in vaccine efficacy. [27, 28]

These immune-enhancing effects are especially relevant in Indonesia, where respiratory infections remain a leading cause of pediatric outpatient visits and hospitalizations. The ability of probiotics to strengthen both gut and systemic immunity provides a valuable adjunct to existing public health measures.

Anti-inflammatory and Metabolic Effects

Inflammation is a common underlying factor in the susceptibility and severity of communicable diseases among children, especially in settings burdened by malnutrition and recurrent infections. Chronic low-grade inflammation, often linked with EED, gut dysbiosis, and inadequate nutrient intake, compromises immune function and nutrient absorption—creating a feedback loop that perpetuates vulnerability.[29, 30]

Probiotics mitigate inflammation through metabolic and immunological pathways. By increasing the production of short-chain fatty acids (SCFAs) notably butyrate that enhance epithelial repair, suppress NF-κB signaling, and reduce pro-inflammatory cytokine release (e.g., IL-6, TNF-α). Probiotics also promote the expansion of regulatory T-cells (Treg), which help maintain immune homeostasis in the face of repeated microbial exposures.[29, 30]

Asian studies illustrate these anti-inflammatory effects clearly. In Korea, SCFA-producing strains reduced systemic inflammatory markers and improved clinical symptoms among children with allergic comorbidities, indicating broader immunoregulatory benefits beyond allergy.[29] A Chinese pediatric trial also found significant reductions in inflammatory

biomarkers in children with recurrent infections who received multi-strain probiotic supplementation.[30] Additional regional data show improved appetite, better weight gain during recovery, and shorter symptom duration in children experiencing diarrheal or respiratory infections. In a controlled field trial of over 1,000 young Vietnamese children, daily intake of fermented milk containing *Lactobacillus casei* Shirota was associated with significantly higher weight gain over a 12-week intervention and 4-week follow-up period compared with control, indicating improved nutritional recovery in the context of reduced infection burden (e.g., acute respiratory infections, diarrheal trends).[31, 32]

These anti-inflammatory mechanisms complement the immune-enhancing and barrier-protective pathways described earlier, reinforcing the central role of probiotics in mitigating infection severity and improving overall resilience in children.

Clinical Outcomes in Asian and Indonesian Settings

The cumulative effect of microbiota modulation, improved barrier integrity, immune enhancement, and anti-inflammatory pathways manifests in significant clinical benefits across Asia. Although the fact that information on gut microbiota in Indonesia children is limited[33], studies from Indonesia and neighboring countries consistently show that probiotics reduce both the frequency and severity of communicable diseases among children. The key clinical outcomes include following points:

Reduced gastrointestinal infections**:**

- Indonesian school-based trials report 20–50% reductions in diarrhea incidence following regular consumption of probiotic milk or supplements.[5, 11]

- Chinese study similarly demonstrate shorter diarrheal episodes, fewer hospital visits, and faster symptom resolution.[34]

Lower respiratory infection rates:

- Multiple Vietnamese RCTs observed reductions in the number and duration of URTIs, alongside measurable decreases in absenteeism.[6]
- Japanese and Malaysian studies reported fewer lower respiratory infections and decreased reliance on antibiotics.[24, 25]

Reduced antibiotic use:

- Clinical studies from Malaysia and Thailand highlight that probiotic-treated children required fewer antibiotic prescriptions, reflecting milder infection profiles and improved recovery.[7, 22]

Better growth and nutritional recovery:

- Improvements in weight gain and appetite during recovery from infection, suggesting indirect benefits on nutritional status.[4]

Those clinical outcomes strongly validate the conceptual framework, demonstrating that probiotics exert measurable, real-world benefits for communicable disease prevention in children particularly in settings where malnutrition, infection, and poor microbiota diversity converge.

Implications for Child Nutrition Programs

Evidence from the reviewed literature consistently highlights the importance of integrating microbiota-targeted nutrition strategies into child nutrition programs, particularly in settings with a high burden of infection and undernutrition. Early-life nutrition interventions

that support gut microbiota development, such as breastfeeding promotion, probiotic- and prebiotic-fortified foods, and synbiotic supplementation are shown to improve immune resilience, gastrointestinal integrity, and growth outcomes in children. [35, 36]

Indonesian data demonstrate that children from lower socioeconomic backgrounds exhibit higher prevalence of potentially pathogenic gut bacteria and reduced microbial diversity, which are closely associated with stunting and poor dietary quality. Studies comparing stunted and non-stunted Indonesian children suggesting that inadequate dietary fiber and fermented food intake may impair microbiota maturation. These findings support the inclusion of microbiota-supportive nutrients within national child nutrition programs, particularly for vulnerable populations.[36, 37]

From a nutrition-programming perspective, probiotics can be incorporated through several feasible delivery routes, including fortified milk[11], yogurt[23], micronutrient powders enriched with probiotic strains[38], and age-appropriate supplements. In Indonesian and regional community settings, where fermented foods are culturally acceptable yet not routinely consumed by children[10], structured education and behavior-change interventions around fermented food intake may encourage adoption. School-based platforms such as UKS and Posyandu also present scalable opportunities for distribution.[39]

Probiotics align with national and global child-health priorities, including reducing stunting, improving micronutrient absorption, enhancing recovery after infection, and reducing antibiotic reliance.[6, 7, 24] Their favorable safety profile and cost-effectiveness make them suitable for integration with established interventions such as complementary feeding

education, micronutrient supplementation, and WASH programs.[40]

Importantly, the mechanisms highlighted in this review indicate that probiotics function synergistically with broader nutrition strategies to strengthen host resilience. In high-burden environments where communicable diseases perpetuate the cycle of undernutrition, routine probiotic intake may help maintain nutrient absorption and support growth trajectories by reducing infection-driven nutrient losses.[11, 22, 24] These implications underscore the potential role of probiotics as a supportive component within comprehensive child nutrition and infectious disease prevention programs across Southeast Asia.

Conclusion

This narrative review demonstrates that probiotics provide a biologically plausible and evidence-supported approach to reducing communicable diseases among children, particularly in Southeast Asia where malnutrition, environmental enteric dysfunction, and high infectious-disease burdens intersect. The mechanisms identified in this review including modulation of gut microbiota composition, reinforcement of intestinal barrier integrity, enhancement of mucosal and systemic immunity, and attenuation of inflammatory responses—operate synergistically to strengthen host resilience against pathogens. Regional studies from Indonesia, Vietnam, Malaysia, China, India, and Thailand consistently show that probiotic supplementation contributes to lower rates of diarrhea and respiratory infections, shorter illness duration, reduced school absenteeism, and improved recovery trajectories.

From a nutrition perspective, probiotics also offer complementary benefits. By improving gut function and supporting micronutrient absorption, probiotics may help

interrupt the infection–malnutrition cycle and facilitate better weight gain during recovery. Evidence from community-based programs suggests that probiotic-fortified foods, fermented milk, and age-appropriate supplements can be feasibly incorporated into child-health interventions. Their affordability, safety, and adaptability to existing systems such as school-based feeding, Posyandu services, and home nutrition counselling that further underscore their potential utility.

Overall, the findings of this review highlight probiotics as a promising adjunct to broader child nutrition and infectious-disease prevention strategies. While probiotics alone cannot address the structural determinants of child health, their integration into routine nutrition programs, alongside improved dietary quality, micronutrient interventions, and WASH initiatives, may offer meaningful health gains in high-burden settings. Future research should prioritize long-term, multi-strain trials in diverse Southeast Asian populations, assess dose–response effects, and evaluate programmatic delivery models to inform scalable implementation. Probiotics represent a practical, nutrition-driven tool with measurable potential to support healthier growth and reduce the burden of communicable diseases among children.

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Conflict of Interest

Authors declare there is no conflict of interest on this publication.

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