Ilam University of Medical Sciences

Plant Biotechnology Persa

Online ISSN: 2676-7414

Homepage: https://pbp.medilam.ac.ir

The Role of Probiotics in the Management of Urinary Tract Infections in Children: A Review of Preclinical and Clinical Evidence

Mohammad Valizadeh [1]✉

[1] Department of Pediatrics, School of Medicine, Urmia University of Medical Sciences, Urmia, Iran

Article Info

Article type:
Review Article

Article History:
Received:
Revised:
Accepted:
Published Online:

✉ ***Correspondence to:***
Mohammad Valizadeh

Email:
mohammad_k_v@yahoo.com

A B S T R A C T

Objective: Urinary tract infection (UTI) is one of the most common bacterial infections in childhood and, if not diagnosed promptly and treated appropriately, may lead to permanent renal scarring and impaired kidney function. In recent years, probiotics have emerged as a promising adjunctive strategy for the prevention and management of UTIs because of their favourable safety profile and their capacity to modulate both the urinary and intestinal microbiota. This review aimed to critically evaluate the current preclinical and clinical evidence regarding the therapeutic and preventive potential of probiotics in paediatric UTIs.

Methods: A narrative literature review was conducted using studies published between 2010 and 2026. Electronic searches were performed in PubMed, Scopus, Web of Science, and Google Scholar. Eligible experimental, preclinical, clinical, systematic review, and meta-analysis studies investigating the effects of probiotic interventions on the prevention or treatment of UTIs in children were identified, screened, and narratively synthesised according to study design and reported outcomes.

Results: Evidence from experimental and clinical studies consistently identified *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Lactobacillus plantarum* PCS26, *Lactobacillus rhamnosus* GG, *Bifidobacterium bifidum*, and *Bifidobacterium lactis* as the probiotic strains with the greatest therapeutic potential. When administered as an adjunct to conventional antibiotic therapy, these probiotics were associated with reduced UTI recurrence, a lower incidence of febrile UTIs, and improved recurrence-free survival. Furthermore, findings from systematic reviews and meta-analyses indicate that species belonging to the genera *Lactobacillus* and *Bifidobacterium* currently provide the strongest evidence for the prevention of recurrent paediatric UTIs. Nevertheless, substantial heterogeneity in probiotic strains, dosages, treatment duration, and study methodologies has limited the development of evidence-based, standardised treatment protocols.

Conclusion: Current evidence suggests that probiotics, particularly species of *Lactobacillus* and *Bifidobacterium*, represent a safe and promising adjunctive approach for reducing recurrence and enhancing the prevention of urinary tract infections in children. However, well-designed mechanistic studies, animal experiments, and large-scale randomised controlled trials are still required to determine the optimal probiotic strains, dosing regimens, and treatment duration before these interventions can be routinely incorporated into paediatric clinical practice.

Keywords: Probiotics, Urinary tract infection, Children, *Lactobacillus*, *Bifidobacterium*

➢ **How to cite this paper**
Valizadeh M. The Role of Probiotics in the Management of Urinary Tract Infections in Children: A Review of Preclinical and Clinical Evidence. Plant Biotechnology Persa. 2026; 8(3): Proof.

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

© The Author(s)

DOI:
Publisher: Ilam University of Medical Sciences

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

Introduction

Childhood diseases represent a major global public health challenge due to their profound impact on children's growth, development, and overall quality of life [1]. Among these conditions, kidney and urinary tract disorders, particularly urinary tract infections (UTIs), are among the most common and clinically significant health problems affecting the pediatric population [1]. Urinary tract infection (UTI) is one of the most common bacterial infections in childhood and remains a major paediatric health concern despite substantial advances in antimicrobial therapy [2]. Urinary tract infection (UTI) is one of the most common bacterial infections affecting children, with millions of new cases reported worldwide each year [3]. In addition to causing acute manifestations such as fever, dysuria, and abdominal pain, delayed diagnosis or inadequate treatment may result in serious long-term complications, including renal scarring, hypertension, impaired renal function, and ultimately chronic kidney disease [2,3]. The burden of UTIs is particularly high among infants and young children owing to the immaturity of the immune system, congenital abnormalities of the urinary tract, and other predisposing factors. Furthermore, recurrent UTIs continue to represent a significant clinical challenge in both paediatric nephrology and paediatric urology [3].

The majority of paediatric UTIs are caused by Gram-negative bacteria, particularly Escherichia coli, which typically originate from the intestinal microbiota and ascend to the urinary tract following colonisation of the perineal region [4]. Although antimicrobial therapy remains the cornerstone of UTI management, the rapid emergence of antimicrobial resistance, disruption of the gut and urinary microbiota, adverse effects associated with prolonged antibiotic use, and the high incidence of recurrent infections have highlighted the need for alternative preventive and adjunctive therapeutic strategies [5]. In recent years, increasing attention has been directed towards the gut–urinary axis, with accumulating evidence indicating that the gut microbiome plays a central role in maintaining urinary tract homeostasis and influencing susceptibility to urinary infections [6].

Among microbiome-based interventions, probiotics have emerged as one of the most promising complementary approaches for the prevention and management of UTIs. Defined as live microorganisms that confer health benefits when administered in adequate amounts, probiotics exert multiple mechanisms that may protect against uropathogen colonisation [7]. Experimental and clinical evidence suggests that Lactobacillus and Bifidobacterium species inhibit the adhesion of uropathogens to uroepithelial cells, compete for epithelial binding sites and available nutrients, produce antimicrobial metabolites such as lactic acid, hydrogen peroxide, and bacteriocins, reduce local pH, reinforce epithelial barrier integrity, and modulate both innate and adaptive immune responses [8]. Furthermore, the restoration and maintenance of a balanced gut and urinary microbiota are increasingly recognised as key mechanisms underlying the protective effects of probiotic therapy [9].

Over the past decade, a growing body of evidence, including in vitro studies, animal experiments, clinical trials, systematic reviews, and meta-analyses, has evaluated the efficacy of probiotics in the prevention and management of paediatric UTIs [10]. Although many of these studies have reported encouraging findings, including reductions in UTI recurrence, decreased antibiotic use, and improved clinical outcomes, substantial heterogeneity in probiotic strains, dosing regimens, treatment duration, patient populations, and study designs has limited the development of definitive clinical recommendations. Consequently, no consensus has yet been reached regarding the most effective probiotic strains, optimal treatment protocols, or the precise role of probiotics within current clinical guidelines for paediatric UTI management.

Given the global rise in antimicrobial resistance, increasing recognition of microbiome preservation as a therapeutic target, and the expanding body of evidence supporting

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

microbiome-based interventions, a comprehensive synthesis of the available preclinical and clinical evidence is both timely and clinically relevant. Accordingly, this narrative review aims to provide an up-to-date overview of the principal probiotic strains investigated to date and to critically evaluate the current experimental and clinical evidence regarding the role of probiotics in the prevention and management of urinary tract infections in children.

Methods

This study was conducted as a narrative review to comprehensively evaluate the available evidence regarding the role of probiotics in the prevention and management of urinary tract infections (UTIs) in children. A systematic literature search was performed in PubMed, Scopus, Web of Science, and Google Scholar to identify relevant studies published between January 2010 and June 2026.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms, including *"probiotics," "Lactobacillus," "Bifidobacterium," "urinary tract infection," "UTI," "children," "paediatrics,"* and *"microbiome"*. Boolean operators (AND and OR) were used to optimise the retrieval of relevant publications.

Eligible studies included in vitro investigations, animal studies, clinical trials, observational studies, systematic reviews, meta-analyses, and narrative reviews that evaluated the effects of probiotic interventions on the prevention, treatment, or recurrence of paediatric UTIs. Studies without accessible full-text articles, case reports, letters to the editor, conference abstracts, publications unrelated to the review topic, and articles published in languages other than English or Persian were excluded.

Following the screening of titles, abstracts, and full-text articles, data were extracted on study design, participant characteristics, probiotic strains, dosing regimens, treatment duration, and the principal therapeutic outcomes. Owing to the narrative nature of this review, the findings were synthesised qualitatively rather than quantitatively. The available evidence was organised according to the level of evidence, with separate evaluation of preclinical studies (including in vitro and animal investigations) and clinical studies, thereby providing a comprehensive overview of the current evidence regarding the role of probiotic therapy in the prevention and management of paediatric urinary tract infections.

Results

The included literature was categorised into two broad groups: (i) experimental and clinical studies and (ii) evidence syntheses, including narrative reviews, systematic reviews, and meta-analyses. Overall, the available evidence suggests that probiotics, particularly strains belonging to the genera *Lactobacillus* and *Bifidobacterium*, may contribute to reducing the recurrence of urinary tract infections (UTIs) in children, prolonging recurrence-free survival, and enhancing the effectiveness of conventional antibiotic therapy. However, the magnitude of these benefits varied across studies owing to differences in study design, probiotic formulations, dosing regimens, treatment duration, and patient populations. The characteristics and principal findings of the included studies are summarised in Tables 1 and 2.

As summarised in Table 1, most experimental and clinical studies reported favourable safety profiles and reductions in recurrent UTIs following probiotic administration. The most consistent therapeutic benefits were observed when probiotics were administered as adjuncts to standard antibiotic therapy. In contrast, several studies reported only numerical reductions in recurrence rates that did not reach statistical significance, highlighting the variability of treatment effects across different clinical settings.

The evidence summarised in Table 2 demonstrated a broadly similar pattern. Systematic reviews and meta-analyses generally reported a modest reduction in the risk of recurrent UTIs among children receiving probiotic

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

supplementation. However, the current evidence remains insufficient to demonstrate the superiority of probiotics over standard management alone. Most review articles also highlighted several mechanisms through which probiotics may exert protective effects, including inhibition of uropathogen colonisation, modulation of host immune responses, reinforcement of epithelial barrier function, and restoration of microbial homeostasis. Nevertheless, they consistently emphasised the need for large, well-designed randomised controlled trials to identify the optimal probiotic strains, dosing regimens, and treatment durations required to support evidence-based clinical recommendations.

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

Table 1: Experimental and Clinical Studies Investigating Probiotics for Paediatric Urinary Tract Infections

Study	Study design	Probiotic strain(s) / intervention	Dose and treatment duration	Main findings	Conclusion	Ref.
Sadeghi-Bojd et al., 2020	Randomised controlled trial (RCT)	Lactobacillus acidophilus, Lactobacillus rhamnosus, Bifidobacterium bifidum, Bifidobacterium lactis	18 months	Significantly prolonged recurrence-free survival in children with recurrent UTIs	Probiotic supplementation was safe and significantly reduced the risk of UTI recurrence.	[11]
Mohseni et al., 2013	Randomised controlled trial (RCT)	Lactobacillus acidophilus + Bifidobacterium lactis combined with nitrofurantoin	10^7 CFU/mL for 3 years	Reduced incidence of febrile UTIs compared with standard therapy	Adjunctive probiotic therapy enhanced the preventive effect of antibiotic prophylaxis.	[12]
Madden-Fuentes et al., 2015	Retrospective study	Fluoroquinolone therapy combined with probiotics	Not reported	Marked reduction in the number of recurrent UTI episodes	Combined antibiotic–probiotic therapy showed promising clinical benefits.	[13]
Meštrović Popovič et al., 2022	Pilot randomised controlled trial	Lactobacillus plantarum PCS26	6 months	Lower recurrence rate, although the difference was not statistically significant	The probiotic demonstrated an excellent safety profile and potential clinical efficacy.	[14]
Groah et al., 2019	Clinical trial	Intravesical Lactobacillus rhamnosus GG	6 months	Good safety and tolerability with no major adverse events	Intravesical probiotic administration appeared safe and may be beneficial in carefully selected patients.	[15]

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

Table 2: Narrative Reviews, Systematic Reviews, and Meta-Analyses Evaluating the Effects of Probiotics on Paediatric Urinary Tract Infections

Study	Study Design	Probiotic Strain(s)/Intervention	Principal Findings	Conclusion	Level of Evidence	Ref.
Schwenger et al., 2015	Systematic review and meta-analysis	Multiple probiotic strains	No statistically significant reduction in recurrent urinary tract infections (UTIs) was observed.	Current evidence is insufficient to support the routine use of probiotics for the prevention of recurrent UTIs.	Meta-analysis	[16]
Meena et al., 2021	Systematic review and meta-analysis	Multiple probiotic strains	Probiotics reduced the risk of recurrent UTIs compared with placebo but did not demonstrate superiority over antibiotic prophylaxis.	Probiotics appear to provide moderate clinical benefit, particularly when compared with placebo.	Meta-analysis	[17]
Emami et al., 2024	Systematic review and meta-analysis	Multiple probiotic strains	A modest reduction in the overall risk of UTIs was observed among individuals receiving probiotics.	The available evidence is encouraging; however, additional high-quality studies are required to strengthen these findings.	Meta-analysis	[18]
Hosseini et al., 2017	Systematic review and meta-analysis	Multiple probiotic strains	Adjunctive probiotic therapy combined with antibiotics achieved superior outcomes compared with antibiotic	Combined probiotic–antibiotic therapy may represent a more effective therapeutic	Meta-analysis	[19]

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

			therapy alone.	strategy.		
Tewary & Narchi, 2015	Narrative review	Lactobacillus spp. and Bifidobacterium spp.	Probiotics may inhibit the adhesion of uropathogenic microorganisms to the urinary tract epithelium.	Further well-designed clinical studies are required to confirm these findings.	Narrative review	[20]
Khan et al., 2019	Narrative review	Various probiotic species	Evidence suggests that probiotics may reduce uropathogen colonisation of the urinary tract.	The current body of evidence remains limited and warrants further high-quality investigation.	Narrative review	[21]
Beyitler & Kavukcu, 2017	Narrative review	Lactobacillus spp. and Bifidobacterium spp.	Probiotics may enhance host immune responses while suppressing the growth of urinary pathogens.	Additional large-scale randomised controlled trials are needed to establish clinical efficacy.	Narrative review	[22]
Caffarelli et al., 2015	Narrative review	Multiple probiotic strains	The available evidence was considered insufficient to support definitive clinical recommendations.	More robust clinical research is required before routine clinical implementation can be recommended.	Narrative review	[23]
Qasemi et al., 2023	Comprehensive review	Various probiotic formulations	Probiotics demonstrated considerable therapeutic potential for the prevention and management of UTIs.	Standardisation of probiotic strains, dosages, and treatment protocols is required before widespread clinical application.	Comprehensive review	[24]

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

Hudson et al., 2022	Narrative review	Probiotics combined with antimicrobial therapy	Combination therapy was associated with a lower incidence of recurrent UTIs than antimicrobial therapy alone.	Adjunctive probiotic supplementation appears to be a promising strategy for reducing UTI recurrence.	Narrative review	[25]

Table 3: Clinical Effectiveness of Probiotics in the Prevention and Management of Paediatric Urinary Tract Infections

Clinical Effectiveness Level	Symbol	Number of Studies (n = 15)	Percentage	Representative Studies	Interpretation of the Evidence
High effectiveness	🟢	4	26.7%	*Sadeghi-Bojd* et al., 2020; *Mohseni* et al., 2013; *Hosseini* et al., 2017; *Hudson* et al., 2022	These studies consistently demonstrated a significant reduction in recurrent urinary tract infections (UTIs), prolonged recurrence-free survival, and improved clinical outcomes when probiotics were administered as an adjunct to antibiotic therapy. Collectively, they provide the strongest evidence supporting the clinical effectiveness of probiotic supplementation.
Moderate effectiveness	🟡	7	46.7%	*Madden-Fuentes* et al., 2015; *Meštrović Popovič* et al., 2022; *Meena* et al., 2021; *Emami* et al., 2024; *Tewary & Narchi*, 2015; *Khan* et al., 2019; *Qasemi* et al., 2023	The available evidence suggests that probiotics may provide clinically meaningful benefits; however, the overall magnitude of these effects remains modest. Interpretation of the findings is limited by substantial heterogeneity in study design, probiotic strains, dosages, treatment regimens, and outcome measures, as well as the absence of statistically significant improvements in several clinical endpoints.
Limited or insufficient	🔴	4	26.7%	*Schwenger* et al., 2015; *Beyitler & Kavukcu*, 2017; *Caffarelli* et al.,	These studies primarily focused on safety, feasibility, or summarising the available literature rather than providing

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

evidence				2015; *Groah* et al., 2019	definitive evidence of clinical efficacy. Consequently, the current evidence is insufficient to support the routine use of probiotics for the prevention or management of paediatric UTIs, highlighting the need for additional high-quality, adequately powered randomised controlled trials.

To facilitate interpretation of the findings, a pragmatic evidence-rating system was adopted. The 🟢 (green) symbol denoted high clinical effectiveness supported by strong evidence, indicating that well-designed studies with consistent findings demonstrated the beneficial effects of probiotics. The 🟡 (yellow) symbol represented moderate clinical effectiveness supported by moderate evidence, reflecting studies that reported favourable outcomes but were limited by methodological heterogeneity, variability in probiotic strains, treatment regimens, or outcome measures, and/or insufficient statistical power, thereby precluding definitive conclusions. The 🔴 (red) symbol indicated limited or insufficient evidence, signifying that the available data were inadequate to establish the clinical effectiveness of probiotics with confidence because of the limited number of studies, inconsistent findings, or the overall low certainty of the evidence. This pragmatic classification was intended to provide readers with a clear and concise summary of the current strength and consistency of the evidence regarding the therapeutic role of probiotics in the prevention and management of paediatric urinary tract infections.

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

Table 4: Evidence Matrix of the Included Studies

Study	Study Design	Probiotic Strain(s) or Intervention	Reduction in UTI Recurrence	Safety	Overall Conclusion	Level of Evidence
Sadeghi-Bojd et al., 2020	Randomised controlled trial (RCT)	Lactobacillus acidophilus, Lactobacillus rhamnosus, Bifidobacterium bifidum, and Bifidobacterium lactis	🟢	🟢	Demonstrated significant efficacy in preventing recurrent UTIs, with an excellent safety profile.	★★★
Mohseni et al., 2013	Randomised controlled trial (RCT)	Lactobacillus acidophilus, Bifidobacterium lactis, plus nitrofurantoin	🟢	🟢	Adjunctive probiotic therapy enhanced the effectiveness of conventional antibiotic treatment while maintaining good tolerability.	★★★
Madden-Fuentes et al., 2015	Retrospective cohort study	Probiotic supplementation combined with fluoroquinolone therapy	🟡	🟢	Probiotic supplementation was associated with a reduced frequency of recurrent UTIs; however, the overall strength of evidence remains moderate.	★★
Meštrović Popovič et al., 2022	Pilot randomised controlled trial	Lactobacillus plantarum PCS26	🟡	🟢	Demonstrated promising preliminary efficacy and a favourable safety profile, supporting the need for larger confirmatory trials.	★★
Groah et al., 2019	Clinical trial	Intravesical Lactobacillus rhamnosus GG	🔴	🔵	The intervention was well tolerated and appeared safe; however, evidence of clinical efficacy remained limited.	★★
Schwenger et al., 2015	Systematic review	Multiple probiotic strains	🔴	⚪	Current evidence is insufficient to support the routine use of probiotics	★★★★

[Downloaded from pbj.medilam.ac.ir on 2026-11-05]

	and meta-analysis				for the prevention of recurrent UTIs.	
Meena et al., 2021	Systematic review and meta-analysis	Multiple probiotic strains	🟡	○	Probiotics reduced the risk of recurrent UTIs compared with placebo but did not demonstrate superiority over antibiotic prophylaxis.	★★★★
Emami et al., 2024	Systematic review and meta-analysis	Multiple probiotic strains	🟡	○	A modest reduction in UTI risk was observed, suggesting potential clinical benefit; however, further high-quality evidence is required.	★★★★
Hosseini et al., 2017	Systematic review and meta-analysis	Multiple probiotic strains	🟢	○	Combined probiotic–antibiotic therapy demonstrated greater effectiveness than antibiotic therapy alone in preventing recurrent UTIs.	★★★★
Tewary & Narchi, 2015	Narrative review	Lactobacillus spp. and Bifidobacterium spp.	🟡	○	Summarised several potential mechanisms of action, including inhibition of uropathogen adhesion and modulation of host immune responses.	★★
Khan et al., 2019	Narrative review	Various probiotic species	🟡	○	Reported evidence suggesting reduced uropathogen colonisation; however, the overall evidence base remains limited.	★★
Beyitler & Kavukcu, 2017	Narrative review	Lactobacillus spp.	🔴	○	Concluded that additional well-designed, high-quality clinical trials are required before firm clinical recommendations can be made.	★★

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

Caffarelli et al., 2015	Narrative review	Multiple probiotic strains	🔴	⚪	The available evidence was considered insufficient to support definitive clinical recommendations regarding probiotic use.	★★
Qasemi et al., 2023	Comprehensive review	Multiple probiotic strains	🟡	⚪	Highlighted the promising therapeutic potential of probiotics while emphasising the need for standardisation of probiotic strains, dosages, and treatment protocols.	★★
Hudson et al., 2022	Narrative review	Probiotics combined with antimicrobial therapy	🟢	⚪	Suggested that adjunctive probiotic therapy may represent a promising strategy for reducing recurrent UTIs and improving clinical outcomes.	★★

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

In this review, the level of evidence was classified according to the study design. Systematic reviews and meta-analyses were assigned the highest level of evidence (★★★★) because they systematically synthesise and critically appraise findings from multiple independent studies, thereby providing the most robust and reliable estimates of intervention effectiveness. Randomised controlled trials (RCTs) were assigned a rating of ★★★, reflecting their high methodological rigour and their pivotal role in establishing causal relationships and evaluating the efficacy of clinical interventions. Pilot trials, retrospective studies, and narrative or comprehensive reviews were assigned ★★, as these study designs provide valuable scientific insights but generally represent a lower level of evidence because of methodological limitations, smaller sample sizes, or the absence of systematic evidence synthesis.

Overall, 15 eligible studies were included in this review, comprising randomised controlled trials, retrospective studies, pilot randomised controlled trials, narrative reviews, comprehensive reviews, and systematic reviews with meta-analyses. The overall appraisal of the evidence demonstrated that 4 studies (26.7%) provided strong evidence of high clinical effectiveness, 7 studies (46.7%) reported moderate or promising clinical effectiveness, and 4 studies (26.7%) provided limited or insufficient evidence regarding the role of probiotics in the prevention and management of paediatric urinary tract infections (UTIs). Collectively, the available evidence suggests that probiotics—particularly when used as an adjunct to conventional antibiotic therapy—may offer clinically meaningful benefits in reducing UTI recurrence while maintaining a favourable safety profile. Nevertheless, the current evidence remains limited by heterogeneity in probiotic strains, dosages, treatment regimens, study populations, and outcome measures. Therefore, additional large-scale, well-designed, adequately powered randomised controlled trials employing standardised probiotic formulations and harmonised treatment protocols are required to strengthen the evidence base and inform routine clinical practice.

Randomised controlled trials (RCTs), particularly those conducted by Sadeghi-Bojd et al. and Mohseni et al., demonstrated that adjunctive administration of *Lactobacillus* and *Bifidobacterium* strains in combination with standard antibiotic therapy significantly reduced the recurrence of urinary tract infections (UTIs), prolonged recurrence-free survival, and improved overall clinical outcomes. These findings were further supported by the systematic review and meta-analysis conducted by Hosseini et al. and the narrative review by Hudson et al., both of which concluded that combined probiotic–antibiotic therapy was more effective than antibiotic therapy alone. Collectively, these studies provide compelling evidence supporting the use of probiotics as a promising adjunctive strategy for the prevention of recurrent paediatric UTIs.

In contrast, studies by Meena et al. (2021), Emami et al. (2024), Meštrović Popovič et al. (2022), Madden-Fuentes et al. (2015), together with several narrative and comprehensive reviews, reported modest reductions in UTI recurrence or overall infection risk. Although these findings suggest potential clinical benefits, the magnitude of the observed treatment effects was generally modest and should be interpreted with caution because of substantial heterogeneity across studies. Differences in probiotic strains, dosages, treatment duration, patient populations, clinical outcome measures, and methodological quality limited direct comparisons and reduced the overall certainty of the evidence.

Conversely, the systematic review by Schwenger et al. and the narrative reviews by Beyitler and Kavukcu and Caffarelli et al. concluded that the current evidence remains insufficient to support the routine use of probiotics for the prevention or treatment of paediatric UTIs. Similarly, the clinical trial conducted by Groah et al., which primarily evaluated the safety of intravesical administration of *Lactobacillus rhamnosus* GG, demonstrated good tolerability and an acceptable safety profile

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

but failed to provide convincing evidence of therapeutic efficacy.

Overall, the synthesis of the available evidence indicates that probiotics particularly strains belonging to the genera *Lactobacillus* and *Bifidobacterium*—represent a safe and promising adjunct to conventional antimicrobial therapy for reducing the risk of recurrent UTIs in children. However, the current evidence remains constrained by substantial heterogeneity in probiotic strain selection, dosage, treatment duration, patient populations, outcome measures, and study methodology, precluding definitive recommendations for routine clinical use. Future research should prioritise large-scale, multicentre, adequately powered randomised controlled trials employing standardised probiotic formulations, harmonised intervention protocols, and clinically relevant outcome measures. Such studies are essential to identify the optimal probiotic strains, dosing regimens, treatment duration, and target patient populations, thereby strengthening the evidence base and informing evidence-based clinical guidelines for the prevention and management of paediatric urinary tract infections.

Discussion

Frequent recurrence, the emergence of antimicrobial resistance, and disruption of the normal microbiota have limited the long-term effectiveness of conventional antibiotic-based management. Over the past decade, increasing recognition of the urinary and gut microbiomes as critical regulators of urinary tract homeostasis and host immune function has stimulated growing interest in probiotics as a safe adjunctive strategy for preventing recurrent UTIs. Recent narrative reviews, systematic reviews, and meta-analyses collectively suggest that probiotics may provide clinically meaningful benefits, particularly when administered alongside standard antimicrobial therapy [20–25].

The principal finding of the present review is that probiotic preparations containing *Lactobacillus* and *Bifidobacterium* species, particularly when used as adjuncts to conventional antibiotic therapy, may reduce the recurrence of paediatric UTIs, decrease the incidence of febrile UTIs, prolong recurrence-free survival, and improve selected clinical outcomes. These observations are supported by the randomised controlled trials conducted by Sadeghi-Bojd et al. and Mohseni et al., which demonstrated superior outcomes with adjunctive probiotic therapy, as well as by the retrospective study of Madden-Fuentes et al., which reported a reduction in recurrent UTI episodes. Similarly, the systematic review and meta-analysis by Hosseini et al. and the narrative review by Hudson et al. concluded that combining probiotics with antibiotics provides greater clinical benefit than antibiotic therapy alone. However, not all studies reached consistent conclusions. The pilot randomised controlled trial by Meštrović Popovič et al. and the systematic review by Schwenger et al. reported encouraging but inconclusive findings, primarily because of considerable heterogeneity across studies and relatively modest treatment effects. These observations underscore the need for additional high-quality evidence before routine clinical implementation can be recommended [11–18].

The beneficial effects of probiotics are likely mediated through multiple complementary biological mechanisms. *Lactobacillus* and *Bifidobacterium* species compete with uropathogens for epithelial adhesion sites, thereby reducing bacterial colonisation of the urinary tract. They also produce antimicrobial metabolites, including lactic acid, bacteriocins, and hydrogen peroxide, which inhibit pathogen growth and virulence. In addition, probiotics modulate innate and adaptive immune responses by enhancing mucosal immunity, regulating inflammatory cytokine production, and strengthening epithelial barrier integrity. Restoration and maintenance of a balanced intestinal and urinary microbiota may further reduce the translocation of enteric uropathogens particularly *Escherichia coli*, the predominant causative organism of paediatric UTIs from the gastrointestinal tract to the urinary tract. These proposed mechanisms are consistent with previous reviews that identified inhibition of

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

uropathogen adhesion, suppression of pathogen colonisation, reinforcement of mucosal barrier function, and immunomodulation as the principal mechanisms underlying probiotic efficacy [20–22].

Despite these encouraging findings, the current evidence should be interpreted cautiously. Considerable heterogeneity exists across published studies with respect to probiotic strains, formulations, dosages, treatment duration, routes of administration, participant characteristics, definitions of recurrent UTI, follow-up periods, and clinical outcome measures. This variability limits direct comparison among studies and reduces confidence in pooled estimates of treatment effect. Although several systematic reviews and meta-analyses have reported modest reductions in recurrent UTI risk, they have consistently concluded that the overall certainty of the evidence remains low to moderate and is insufficient to support the routine clinical use of probiotics. Consequently, well-designed mechanistic investigations, translational studies, and adequately powered multicentre randomised controlled trials using standardised probiotic formulations and harmonised outcome measures are required to identify the most effective probiotic strains, optimal dosages, treatment durations, and patient populations most likely to benefit from probiotic therapy [16–19, 23–25].

Another important consideration is that probiotics should currently be regarded as an adjunct rather than a replacement for antimicrobial therapy. None of the available evidence supports substituting probiotics for established antibiotic treatment in children with acute UTIs. Instead, their greatest potential clinical value may lie in reducing recurrent infections, preserving microbiome integrity, and decreasing cumulative antibiotic exposure, thereby contributing to antimicrobial stewardship. Future studies should also evaluate long-term safety, cost-effectiveness, strain-specific efficacy, and personalised probiotic approaches based on microbiome composition, which may facilitate precision medicine strategies for preventing paediatric UTIs.

Early diagnosis and timely management of childhood diseases [26], particularly kidney and urinary tract disorders, are essential for preventing long-term complications and improving health outcomes. Furthermore, the implementation of emerging therapeutic approaches has the potential to enhance treatment efficacy and reduce the risk of disease recurrence [27].

Conclusion

The evidence synthesised in this narrative review indicates that probiotics, particularly strains belonging to the genera *Lactobacillus* and *Bifidobacterium*, represent a safe and promising adjunct to conventional therapy for paediatric urinary tract infections. Current evidence suggests that probiotic supplementation may reduce UTI recurrence, decrease the incidence of febrile UTIs, prolong recurrence-free survival, and improve selected clinical outcomes when administered alongside standard antibiotic therapy. These benefits are biologically plausible and are supported by an expanding body of experimental, clinical, and evidence-synthesis research. Nevertheless, the existing literature remains heterogeneous with respect to probiotic strain selection, formulation, dosage, treatment duration, study populations, clinical outcome measures, and methodological quality. Furthermore, several systematic reviews and meta-analyses have concluded that the overall certainty of the available evidence remains low to moderate, with relatively modest treatment effects and insufficient consistency to justify universal clinical recommendations. Consequently, probiotics cannot currently be recommended as a substitute for established antimicrobial therapy or for routine use in all children with UTIs. Overall, probiotics should be considered a promising adjunctive intervention with the potential to enhance the prevention and management of recurrent paediatric UTIs. However, their incorporation into routine clinical practice will require robust evidence from large-scale, multicentre, adequately powered randomised controlled trials employing standardised probiotic formulations and clinically

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

relevant outcome measures. In parallel, mechanistic and translational studies should further elucidate host–microbiome interactions, identify the most effective probiotic strains and dosing regimens, determine optimal treatment duration, and define the paediatric populations most likely to benefit. Such research will strengthen the evidence base, inform future clinical guidelines, and facilitate the evidence-based integration of probiotics into the prevention and management of paediatric urinary tract infections.

Statements and Declarations

Funding support

The authors did not receive support from any organization for the submitted work.

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Author contributions

MV: Conceptualization, the original draft writing, investigation, writing including reviewing and editing and investigation and formal analysis; MV: Conceptualization, supervision, and project administration; MV Conceptualization, the original draft writing, investigation, writing including reviewing and editing.

Acknowledgments

The authors would like to express their gratitude to the clinical research development unit of Imam Khomeini Hospital, Urmia University of Medical Sciences, for English editing.

References

1. Abbasi E, Ghazavi A, Amouzadeh MH, Valizadeh M, Matinkhah M. Evaluation of the efficacy of levetiracetam plus iron in comparison with iron alone in controlling and reducing the frequency of breath-holding spells in children aged 6 months to 5 years. Iran J Child Neurol. 2020;14(4):43-52.
2. Abbasi A, Valizadeh M, Fahimi D, Moghtaderi M, Bazargani B, Mojtahedi SY, et al. Heath-related quality of life in Iranian children with nephrotic syndrome. Iran J Pediatr. 2022;32(2):e118426. doi:10.5812/ijp-118426.
3. Bhat RG, Katy TA, Place FC. Pediatric urinary tract infections. Emerg Med Clin North Am. 2011;29(3):637-53.
4. Silva ACSE, Oliveira EA, Mak RH. Urinary tract infection in pediatrics: An overview. J Pediatr (Rio J). 2020;96(Suppl 1):65-79.
5. Robino L, Scavone P, Araujo L, Algorta G, Zunino P, Pírez MC, et al. Intracellular bacteria in the pathogenesis of *Escherichia coli* urinary tract infection in children. Clin Infect Dis. 2014;59(11):e158-64.
6. Whiteside SA, Razvi H, Dave S, Reid G, Burton JP. The microbiome of the urinary tract: A role beyond infection. Nat Rev Urol. 2015;12(2):81-90.
7. Williams NT. Probiotics. Am J Health Syst Pharm. 2010;67(6):449-58.
8. Gupta V, Garg R. Probiotics. Indian J Med Microbiol. 2009;27(3):202-9.
9. Isolauri E, Salminen S, Ouwehand AC. Probiotics. Best Pract Res Clin Gastroenterol. 2004;18(2):299-313.
10. Daniel M, Szymanik-Grzelak H, Turczyn A, Pańczyk-Tomaszewska M. *Lactobacillus rhamnosus* PL1 and *Lactobacillus plantarum* PM1 versus placebo as a prophylaxis for recurrent urinary tract infections in children: A study protocol for a randomised controlled trial. BMC Urol. 2020;20(1):168.
11. Sadeghi-Bojd S, Naghshizadian R, Mazaheri M, Ghane Sharbaf F, Assadi F. Efficacy of probiotic prophylaxis after the first febrile urinary tract infection in children with normal urinary tracts. J Pediatric Infect Dis Soc. 2020;9(3):305-10.
12. Mohseni MJ, Aryan Z, Emamzadeh-Fard S, Paydary K, Mofid V, Joudaki H, et al. Combination of probiotics and antibiotics in the prevention of recurrent urinary tract infection in children. Iran J Pediatr. 2013;23(4):430-8.
13. Madden-Fuentes RJ, Arshad M, Ross SS, Seed PC. Efficacy of fluoroquinolone/probiotic combination therapy for recurrent urinary tract infection in children: A retrospective analysis. Clin Ther. 2015;37(9):2143-7.

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

14. Meštrović Popovič K, Povalej Bržan P, Langerholc T, Marčun Varda N. The impact of *Lactobacillus plantarum* PCS26 supplementation on the treatment and recurrence of urinary tract infections in children: A pilot study. J Clin Med. 2022;11(23):7008.
15. Groah SL, Rounds AK, Ljungberg IH, Sprague BM, Frost JK, Tractenberg RE. Intravesical *Lactobacillus rhamnosus* GG is safe and well tolerated in adults and children with neurogenic lower urinary tract dysfunction: First-in-human trial. Ther Adv Urol. 2019;11:1756287219875594.
16. Schwenger EM, Tejani AM, Loewen PS. Probiotics for preventing urinary tract infections in adults and children. Cochrane Database Syst Rev. 2015;(12):CD008772.
17. Meena J, Thomas CC, Kumar J, Raut S, Hari P. Non-antibiotic interventions for prevention of urinary tract infections in children: A systematic review and meta-analysis of randomized controlled trials. Eur J Pediatr. 2021;180(12):3535-45.
18. Emami E, Sherwin CM, Heidari-Soureshjani S. Effect of probiotics on urinary tract infections in children: A systematic review and meta-analysis. Curr Rev Clin Exp Pharmacol. 2024;19(1):111-21.
19. Hosseini M, Yousefifard M, Ataei N, Oraii A, Razaz JM, Izadi A. The efficacy of probiotics in prevention of urinary tract infection in children: A systematic review and meta-analysis. J Pediatr Urol. 2017;13(6):581-91.
20. Tewary K, Narchi H. Recurrent urinary tract infections in children: Preventive interventions other than prophylactic antibiotics. World J Methodol. 2015;5(2):13-9.
21. Khan A, Jhaveri R, Seed PC, Arshad M. Update on associated risk factors, diagnosis, and management of recurrent urinary tract infections in children. J Pediatric Infect Dis Soc. 2019;8(2):152-59.
22. Beyitler I, Kavukcu S. Probiotics for prophylaxis and treatment of urinary tract infections in children.
23. Caffarelli C, Cardinale F, Povesi-Dascola C, Dodi I, Mastrorilli V, Ricci G. Use of probiotics in pediatric infectious diseases. Expert Rev Anti Infect Ther. 2015;13(12):1517-35.
24. Qasemi A, Lagzian M, Rahimi F, Majd FK, Bayat Z. The power of probiotics to combat urinary tract infections: A comprehensive review. Res Biotechnol Environ Sci. 2023;2(1):1-11.
25. Hudson RE, Job KM, Sayre CL, Krepkova LV, Sherwin CM, Enioutina EY. Examination of complementary medicine for treating urinary tract infections among pregnant women and children. Front Pharmacol. 2022;13:883216
26. Abbasi E, Ghazavi A, Amouzadeh MH, Valizadeh M, Sepahi MA. Status epilepticus and coma leading to death in a boy caused by medium-chain acyl-CoA dehydrogenase deficiency. Iran J Child Neurol. 2021;15(4):89-94.
27. Alvarez-Olmos MI, Oberhelman RA. Probiotic agents and infectious diseases: A modern perspective on a traditional therapy. Clin Infect Dis. 2001;32(11):1567-76.

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]

[Downloaded from pbp.medilam.ac.ir on 2026-11-05]