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Application of probiotics consumption in patients with kidney and urinary tract diseases; a systematic review of clinical evidence and mechanistic insights

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ABSTRACT

Introduction: Kidney and urinary tract diseases pose a significant health burden, and probiotics, by modulating gut and urogenital microbiota, may offer supportive benefits in this field. This review systematically evaluates the current literature to clarify the role of probiotic consumption in nephrology and urology.

Materials and Methods: A systematic review was conducted in accordance with PRISMA guidelines, with comprehensive searches performed in PubMed/MEDLINE, Embase, Scopus, Web of Science, Cochrane Library, and Google Scholar from inception to December 2025 without language restrictions; search strategies combined MeSH terms and keywords for probiotics, kidney diseases, and urinary tract infections (UTIs) using Boolean operators, and additional studies were identified through manual reference list searches; two independent reviewers screened titles, abstracts, and full texts against predefined criteria, extracted data using a standardized form, and assessed methodological quality with the Cochrane Risk of Bias tool for randomized controlled trials and the Newcastle–Ottawa Scale for observational studies.

Results: This systematic review of 16 randomized and cross-sectional studies involving 2,667 participants across 12 countries found that probiotics may offer therapeutic benefits in kidney and urinary tract diseases. In chronic kidney disease (CKD) populations, probiotics showed potential in reducing uremic toxins, improving glycemic control, lowering inflammation, and enhancing quality of life, though some studies reported neutral or adverse effects, such as increased interleukin 6 (IL-6) or uremic markers in dialysis patients. In UTI, Lactobacillus-based probiotics were generally safe and effective in reducing recurrence, improving outcomes when combined with antibiotics, and lowering bacterial resistance, although certain strains demonstrated limited or no benefit.

Conclusion: In conclusion, probiotics may serve as a safe adjunctive therapy in kidney and urinary tract diseases, but strain- and patient-specific responses as well as optimal formulations, dosing, and long-term effects require confirmation through larger, well-designed trials.

Registration: This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD420251273335) and the Research Registry (UIN: reviewregistry2068) websites.

Implication for health policy/practice/research/medical education:
This systematic review found that probiotics show promising but variable effects in kidney and urinary tract diseases, with potential benefits in reducing uremic toxins, improving metabolic and inflammatory markers, enhancing quality of life, and lowering urinary tract infection (UTI) recurrence, though outcomes differed across strains and patient groups; overall, probiotics appear safe and supportive, but larger, well-designed trials are needed to establish optimal use and long-term impact.

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Review

Introduction

Chronic kidney disease (CKD) and urinary tract infections (UTIs) represent two of the most pressing public health challenges worldwide, contributing significantly to morbidity, mortality, and escalating healthcare expenditures. Annually, CKD affects approximately 10% of the global adult population, characterized by progressive renal dysfunction that leads to end-stage renal disease in advanced cases, often necessitating dialysis or transplantation (1,2). UTIs, meanwhile, are among the most common bacterial infections, with recurrent episodes particularly burdensome for women (3).

A growing body of evidence highlights the role of the gut microbiota in modulating renal and urogenital health through the bidirectional gut-kidney axis, where dysbiosis, disruption of microbial equilibrium, exacerbates disease progression by promoting uremic toxin accumulation, intestinal barrier impairment, and chronic inflammation (4). This axis underscores the potential for microbiome-targeted interventions, such as probiotics, live microorganisms that, when administered in adequate amounts, confer health benefits by restoring microbial diversity and function (5). In the context of rising antimicrobial resistance, driven by antibiotic overuse in UTI management, probiotics offer a promising non-antibiotic strategy to mitigate infection recurrence and support renal function, potentially reducing the global burden of these diseases and addressing the limitations of conventional therapies (6).

The current state of knowledge on probiotics in kidney and urinary tract diseases reveals encouraging evidence of their therapeutic potential, primarily through modulation of the gut microbiota and its metabolites (7). Studies indicated that probiotic supplementation, particularly with strains such as *Lactobacillus rhamnosus* GG and *Faecalibacterium prausnitzii* can lower serum levels of pro-inflammatory cytokines (8). A meta-analysis of 10 randomized controlled trials (RCTs) demonstrated a significant reduction in urea levels (mean difference -30.01 mg/dL; 95% CI -56.78 to -3.25) in non-dialysis CKD patients receiving probiotics, though effects on creatinine and estimated glomerular filtration rate (eGFR) were inconsistent (1). In UTIs, probiotics, especially *Lactobacillus* species, have demonstrated efficacy in preventing recurrence by competitively inhibiting uropathogens like Escherichia coli, producing antimicrobial substances such as bacteriocins, and restoring vaginal and urinary microbiota dominated by beneficial lactobacilli (9). Clinical trials, including a double-blind placebo-controlled study of 174 premenopausal women, reported a 40-70% reduction in symptomatic UTI episodes with vaginal or combined oral-vaginal probiotic administration over four months, alongside extended time to first recurrence (10). Overall, these studies suggest that probiotics can interrupt the vicious cycle of dysbiosis-driven pathology in both CKD and UTIs, offering benefits in inflammation control, toxin reduction, and infection prophylaxis without promoting antimicrobial resistance; however, their exact effectiveness is debatable. These gaps underscore the need for additional research to resolve discrepancies, standardize protocols, and elucidate long-term impacts, ultimately informing evidence-based guidelines for probiotic use in kidney and urinary tract diseases.

Objectives

The objective of this study is to systematically evaluate and synthesize the available clinical evidence on the use of probiotics in patients with kidney and urinary tract diseases. Specifically, the review aims to assess the impact of probiotic supplementation on clinical outcomes, quality of life, and recurrence of UTI, and to provide insights for adjunctive therapy.

Materials and Methods

Study design

The study was designed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (11). A comprehensive search strategy was developed to identify relevant clinical studies evaluating the effects of probiotics in patients with kidney and urinary tract diseases.

Search strategy

For this systematic review on the application of probiotics in patients with kidney and urinary tract diseases, three main search blocks were conducted, including probiotics, kidney diseases, and urinary tract diseases. For the probiotics block, keywords included probiotic, *Lactobacillus*, *Bifidobacterium*, *Saccharomyces*, and gut microbiota, with MeSH terms "Probiotics"[MeSH], "Lactobacillus"[MeSH], and "Bifidobacterium"[MeSH]. For kidney diseases, keywords included chronic kidney disease, CKD, renal failure, end-stage renal disease (ESRD), nephropathy, dialysis, and hemodialysis, with MeSH terms "Kidney Diseases"[MeSH], "Renal Insufficiency, Chronic"[MeSH], and "Renal Dialysis"[MeSH]. For urinary tract disease, keywords included urinary tract disease, cystitis, pyelonephritis, and urogenital infection, with MeSH terms "Urinary Tract Infections"[MeSH], "Cystitis"[MeSH], and "Pyelonephritis"[MeSH]. Boolean operators were applied to combine these blocks, using OR within each block to capture synonyms and AND between blocks to ensure the intersection of concepts. Electronic searches were conducted in PubMed/MEDLINE, Embase, Scopus, Web of Science, Cochrane Library, and Google Scholar from inception to December 2025, without language restrictions. Search strategies were adapted to the syntax of each database. In addition, a manual search of the reference lists of all included articles and relevant reviews was performed to identify additional eligible studies not captured by database

searches. The following query shows the PubMed search strategy: ("Probiotics"[MeSH] OR probiotic*[tiab] OR Lactobacillus [tiab] OR Bifidobacterium[tiab]) AND ("Kidney Diseases"[MeSH] OR chronic kidney disease [tiab] OR CKD [tiab] OR ESRD [tiab] OR dialysis[tiab] OR "Urinary Tract Infections"[MeSH] OR UTI[tiab] OR cystitis[tiab]) AND ("Humans"[MeSH] AND adult[tiab]).

PICO Component

- Population (P): Adults with kidney disease at various stages and urinary tract diseases.
- Intervention (I) /Exposure: Probiotic supplementation
- Comparison (C): Placebo, standard therapy, or no probiotic intervention.
- Outcome (O): Clinical and laboratory outcomes and quality of life.

Eligibility criteria

The eligibility criteria for this systematic review included only clinical studies conducted on adult human participants that specifically examined the effects of probiotics. Studies that investigated synbiotics or prebiotics in combination with probiotics were excluded to ensure a focused evaluation of probiotic interventions. Additionally, case reports, narrative, systematic reviews or meta-analysis, in vitro and in vivo experimental studies, articles involving pediatric populations, animal studies, and low-quality studies were excluded, thereby restricting the analysis to human adult trials that directly assessed probiotic supplementation in kidney and urinary tract diseases.

Quality assessment

The quality of the included studies was assessed using two validated tools with distinct scoring systems. For RCTs, the Cochrane Risk of Bias checklist was applied, which evaluates domains such as random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, completeness of outcome data, selective reporting, and other potential sources of bias. Each domain is scored as "low risk," "high risk," or "unclear risk, and the overall quality of the study is judged based on the cumulative risk profile across domains (12). The quality of cross-sectional studies was assessed using the adapted Newcastle-Ottawa Scale for cross-sectional studies (NOS-xs), which applies a nine-star rating system across three domains: study sample selection (up to 4 stars), assessment of exposure(s) and outcome(s) (up to 3 stars), and control of confounding factors (up to 2 stars). Based on the total score, studies were categorized as high risk of bias (0–3 stars), moderate risk (4–6 stars), or low risk (7–9 stars). For descriptive cross-sectional studies, the simplified NOS-xs2 tool was used, featuring a four-star rating system that evaluates three key items (sample selection, outcome assessment, and confounding) (13). All evaluations were performed independently by two reviewers, and any discrepancies were resolved through discussion or adjudication by a third reviewer to ensure consistency and methodological rigor. All included studies had medium or high quality, and studies with low quality were excluded.

Data extraction

Data extraction was performed using a standardized form, including the first author, year of publication, study design, country, sample size, target population, type of disease, objectives, main findings, and conclusions. Two reviewers independently extracted the data, and any discrepancies between them were resolved through discussion or, when necessary, consultation with a third reviewer.

Results

From the initial database search, 1,328 records were identified, of which 697 duplicates were removed, leaving 631 studies for screening. After title and abstract review, 487 articles were excluded, and 144 were selected for retrieval, though 89 could not be obtained. The remaining 55 full-text articles were assessed for eligibility, with 39 excluded due to being case reports, reviews, experimental studies, pediatric articles, animal research, or low-quality studies. Ultimately, 16 studies met the inclusion criteria and were incorporated into the final review (Figure 1).

The systematic review included 16 RCTs and cross-sectional studies encompassing a total of 2,667 participants across all articles. The studies were conducted in diverse countries, including Brazil, Finland, India, Mexico, Kosovo, China, France, the United States, Canada, Iraq, Malaysia, and Norway. The target populations were adults with CKD at various stages (non-dialysis, hemodialysis, stage 3–5, diabetic nephropathy, and end-stage renal disease), as well as women with acute or recurrent UTIs and patients with lower urogenital tract infections. Overall, findings showed that probiotics demonstrated potential benefits in CKD by reducing uremic toxins, improving glycemic control, lowering inflammation, and enhancing quality of life, though some trials reported neutral or even adverse effects such as increased IL-6 or uremic markers in dialysis patients. In urinary tract diseases, probiotics, particularly *Lactobacillus* formulations, were generally safe and effective in reducing recurrence rates, improving treatment outcomes when combined with antibiotics, and lowering bacterial resistance, although certain strains (e.g., *Lactobacillus* GG drink, vaginal lactobacilli in cystitis-prone women) showed limited or no benefit (Table 1).

Discussion

The results from this systematic review study indicated that probiotic supplementation may offer beneficial but inconsistent effects in patients with kidney and urinary tract diseases. Reported advantages include reductions in uremic toxins, improved metabolic control, decreased systemic inflammation, enhanced quality of life, and

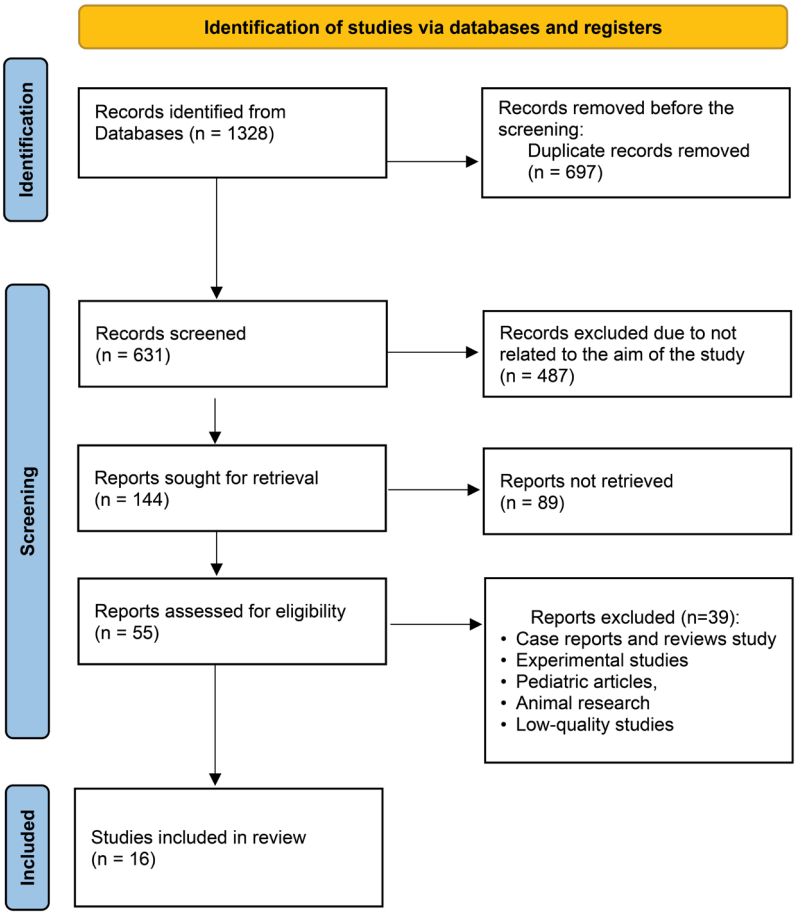

Figure 1. The PRISMA flowchart of the study selection.

lower recurrence of UTI, especially when combined with antibiotic therapy. Nonetheless, outcomes varied, with some studies showing limited or negative results, highlighting the need to consider probiotic strain, patient profile, and disease stage in clinical application. The findings from this systematic review underscore the potential of probiotic supplementation as a therapeutic adjunct in managing kidney and urinary tract diseases, revealing a pattern of beneficial yet inconsistent outcomes across diverse patient populations. Specifically, the observed reductions in uremic toxins align with the understanding that probiotics can modulate the gut microbiota to limit the production and systemic absorption of these metabolites, thereby alleviating the toxic burden on renal function (30,31). Improvements in metabolic control, including glycemic and lipid profiles, suggest that probiotics may enhance overall homeostasis, potentially by fostering beneficial microbial species that influence host metabolism through short-chain fatty acid production and reduced inflammation (31,32). Decreased systemic inflammation, evidenced by lower cytokine levels and oxidative stress markers, further supports this, as probiotics appear to reinforce the intestinal barrier and dampen immune overactivation via the gut-kidney axis (33-35). In urinary tract contexts, the lower recurrence of infections, particularly when probiotics are combined with antibiotics, indicates a role in restoring local microbial balance and inhibiting pathogen adhesion, offering a practical means to mitigate antibiotic resistance and relapse (33,36). These advantages also extend to enhanced quality of life, likely stemming from cumulative effects on symptom burden and daily functioning, which resonate with broader reports of probiotics improving patient well-being in chronic conditions (30,37). Collectively, these results imply that probiotics could serve as a non-invasive, low-risk intervention to complement standard therapies, potentially slowing disease progression and reducing healthcare burdens associated with complications like dialysis dependency or recurrent infections.

When contextualized within the existing literature, the inconsistencies observed in this review, such as limited or negative results in some studies, mirror longstanding debates on probiotic efficacy, where outcomes often hinge on strain-specificity, dosage, and patient heterogeneity rather than a universal effect. For instance, while meta-analyses have consistently demonstrated probiotic benefits in reducing uremic toxins and inflammation in CKD subsets like diabetic kidney disease, variability in

Table 1. The overall information of the included studies in this systematic review

First author (year)	Study design	Location	Sample size	Target population	Type of disease	Objective	Findings	Conclusion
de Araújo É MR (2023) (14)	RCT	Brazil	70 patients (32 probiotics, 38 placebo)	Adult patients with CKD on HD	Kidney	To examine whether daily oral probiotic supplementation can influence inflammatory and metabolic biomarkers	Probiotic supplementation decreased syndecan-1 and blood glucose significantly; CRP also decreased; hemoglobin and hematocrit increased	Probiotics in advanced CKD were associated with decreased syndecan-1 and glucose, suggesting improved metabolism and reduced systemic inflammation
Kontiokari T (2001) (15)	RCT	Finland	150 women	Women with UTI	Urinary tract	Cranberry juice vs. *Lactobacillus* for UTI recurrence prevention	Cranberry-lingonberry juice reduced recurrence significantly; *Lactobacillus* GG drink showed no benefit compared to control	To prevent recurrences of symptomatic UTI in women, the *Lactobacillus* GG drink was ineffective
Kalidindi RK (2024) (16)	Phase IV RCT	India	60 patients (30 Lobun Forte, 30 Renadyl)	Adults with stage 3–4 CKD	Kidney	To compare the clinical effectiveness and safety of two multi-strain probiotic formulations in CKD stages 3–4	Both probiotics improved the QoL and significantly reduced indoxyl sulfate, and improved renal markers, while uric acid decreased significantly only with Lobun Forte®. Inflammatory and oxidative stress markers improved with Lobun Forte®.	Both probiotic formulations enhanced QoL and improved uremic toxins, renal function, inflammatory and oxidative stress markers, and eGFR in CKD stages 3–4, suggesting potential to slow CKD progression via gut–kidney axis modulation.
Miranda Alatriste PV (2014) (17)	Non-blinded RCT	Mexico	30 patients (15 per group)	Adults with stage 3–4 CKD	Kidney	To determine whether two different doses of LcS can reduce blood urea by ≥10% in CKD stage 3–4 patients.	The higher dose (16×10^9 CFU) produced a >10% reduction in blood urea, while the lower dose (8×10^9 CFU) produced a smaller, non-significant reduction. Creatinine did not significantly change.	LcS supplementation at 16×10^9 CFU resulted in a clinically meaningful (>10%) reduction in serum urea in CKD stage 3–4 patients, suggesting potential benefit in lowering uremic toxins.
Mula D (2024) (18)	RCT	Kosovo	897 patients	Adult patients with lower urogenital tract infections	Urinary tract	To compare clinical outcomes of antibiotic therapy with and without probiotic supplementation in patients with lower urogenital tract infections.	Probiotic co-administration improved patient-reported outcomes and reduced persistent infection rates. Only 9.8% of the probiotic group required further treatment vs. 26.1% in the antibiotics-only group. Probiotic use was associated with lower bacterial resistance.	Adding probiotics to antibiotic therapy may reduce adverse effects, enhance treatment effectiveness, and lower bacterial resistance.
de Faria Barros A (2018) (19)	Double-blind RCT	Brazil	30 patients (15 probiotic, 15 placebo)	Non-dialysis CKD patients	Kidney	To evaluate whether probiotic supplementation affects uremic toxins and inflammatory biomarkers in non-dialysis CKD patients.	Probiotic supplementation did not reduce uremic toxins and unexpectedly increased IL-6 levels after 3 months. No improvements were observed in other inflammatory markers.	Probiotics did not provide expected benefits and may worsen inflammation in non-dialysis CKD patients
Jiang H (2021) (20)	Double-blind RCT	China	76 analyzed (42 probiotic, 34 placebo)	Patients with diabetic nephropathy	Kidney	To determine whether probiotic supplementation improves glycemic control and renal function in patients with diabetic nephropathy.	Probiotics significantly reduced fasting glucose, HbA1c, and microalbumin/creatinine ratio after 12 weeks, but did not significantly change postprandial glucose or eGFR.	Probiotic supplementation improved glycemic control in diabetic nephropathy and may have therapeutic potential.
Wagner S (2022) (21)	Cross-sectional	France	888 participants	Adults with CKD stages 3–5	Kidney	To investigate the association between probiotic intake and inflammation in CKD	Probiotic and yoghurt intake were associated with lower inflammation, independent of confounders; no dose-response effect	Probiotic or yoghurt intake is associated with lower inflammation in CKD patients, but without a dose-effect relationship.

Table 1. Continued

First author (year)	Study design	Location	Sample size	Target population	Type of disease	Objective	Findings	Conclusion
Czaja CA (2007) (22)	Phase I RCT	United States	30 women	Premenopausal women with recurrent UTI	Urinary tract	To assess safety and tolerance of *Lactobacillus crispatus* CTV-05 vaginal suppository for preventing recurrent UTI	*Lactobacillus crispatus* CTV-05 was safe, caused mild symptoms similar to placebo; some women developed asymptomatic pyuria; vaginal flora remained stable; no severe adverse events.	*Lactobacillus crispatus* CTV-05 vaginal suppository is safe and well tolerated; may cause mild inflammation; suitable for further study in UTI prevention.
Reid G (1992) (23)	RCT	Canada	41 adult women	Adult women with acute lower UTI	Urinary tract	To evaluate the recurrence of UTI after antimicrobial therapy and *Lactobacillus* vaginal suppositories	TMP/SMX eradicated the infection in 95% of cases; however, recurrence occurred in 29% of patients treated with norfloxacin and 41% of those treated with TMP/SMX. In contrast, the use of *Lactobacillus* suppositories reduced the recurrence rate to 21%.	*Lactobacillus* vaginal suppositories are safe and may reduce UTI recurrence after antibiotics
Mishra A (2024) (24)	Double-blind RCT	India	51 enrolled (25 probiotic, 26 placebo)	Women aged 18–50 with recurrent UTI	Urinary tract	To assess the effect of add-on multi-strain probiotics in preventing recurrent UTI	The probiotic group had a significantly lower recurrence rate (75% recurrence-free vs. 33% in the placebo group; p = 0.007). Mean UTI episodes are lower, but the difference is not statistically significant. NGF and M-CSF decreased in both groups without a between-group difference	Multi-strain probiotics significantly reduced UTI recurrence; may be a valuable adjunct therapy
Borges NA (2018) (25)	Double-blind RCT	Brazil	(16 probiotic, 17 placebo)	Adult HD patients with CKD	Kidney	To evaluate the effects of probiotic supplementation on gut microbiota profile and inflammatory markers in CKD patients on HD	Probiotics increased serum urea, potassium, and indoxyl sulfate; reduced fecal pH; no improvement in inflammatory markers or gut microbiota; no reduction in uremic toxins	Probiotic supplementation did not reduce uremic toxins or inflammation; may require caution in HD patients
Rahman WK (2024) (26)	RCT	Iraq	28 participants	Patients with ESRD on regular hemodialysis	Kidney	To assess therapeutic benefits of probiotics in ESRD patients	Probiotic group showed a significant reduction in blood urea and phosphorus; no significant changes in other biomarkers	Oral probiotics for 8 weeks improved urea and phosphorus levels but did not affect other biomarkers
Stapleton AE (2011) (27)	Phase 2 RCT	United States	100 participants	Premenopausal women with recurrent UTI	Urinary tract	To evaluate whether intravaginal *Lactobacillus crispatus* (Lactin-V) prevents recurrent UTI after treatment for acute cystitis	Lactin-V reduced recurrent UTI (15% vs 27%); high vaginal colonization strongly protective	Lactin-V after cystitis treatment reduces recurrent UTI
Firouzi S (2015) (28)	Double-blind RCT	Malaysia	136 participants (68 probiotic, 68 placebo)	Type 2 diabetes (renal profile and liver function outcomes)	Kidney	To investigate the effect of Multi-strain microbial cell (*Lactobacillus*, etc) preparation on renal profile and liver function in type 2 diabetics	Probiotic significantly reduced serum urea; no significant changes in other renal or liver markers	12-week probiotic supplementation significantly improved urea levels; no significant effect on other renal or liver parameters
Baerheim A (1994) (29)	Double-blind RCT	Norway	47 women	Women aged 18–50 with recurrent lower UTI	Urinary tract	To examine whether vaginal application of *Lactobacillus casei* var. *rhamnosus* reduces reinfection rate in cystitis-prone women	No reduction in UTI incidence; incidence rate; no increased periurethral colonization by lactobacilli	Vaginal lactobacilli did not reduce UTI recurrence

RCT: Randomized clinical trial, CKD: Chronic kidney disease, UTI: Urinary tract infection, LcS: *Lactobacillus casei* Shirota, CFU: Colony-forming units, QoL: Quality of life, IL-6: Interleukin-6, eGFR: estimated glomerular filtration rate, TMP/SMX: Trimethoprim/sulfamethoxazole, NGF: nerve growth factor, M-CSF: Macrophage colonystimulating factor, HD: hemodialysis, ESRD: End-stage renal disease, CRP: C-reactive protein

trial designs and participant profiles (e.g., disease stage or comorbidities) frequently leads to heterogeneous results, much like the mixed findings here (31,32,38). This aligns with general evidence from randomized controlled trials in peritoneal dialysis patients, where multi-strain formulations show promise in preserving residual renal function and modulating cytokines, yet single-strain or short-duration interventions yield subdued responses (35,39). Similarly, for UTI, the synergistic effect with antibiotics echoes reviews highlighting probiotics' role in preventing recolonization by uropathogens, though efficacy wanes without tailored strain selection (36,40). Such parallels emphasize that the inconsistencies are not anomalies but reflections of the gut-kidney axis's complexity, where dysbiosis-driven toxin accumulation and immune dysregulation vary by individual factors.

Overall, this systematic review demonstrates that probiotic supplementation yields beneficial, albeit inconsistent, effects in patients with kidney and urinary tract diseases, with key advantages including reductions in uremic toxins, improved metabolic control, decreased systemic inflammation, enhanced quality of life, and reduced UTI recurrence, particularly when paired with antibiotic therapy. These findings, grounded in the aggregated evidence, affirm probiotics' role in mitigating core pathophysiological elements like toxin accumulation and inflammatory cascades without introducing unsupported claims of universality. The variability observed underscores the necessity of tailoring interventions to probiotic strain, patient profile, and disease stage, ensuring that applications remain evidence-informed rather than presumptive.

Conclusion

In conclusion, this systematic review highlights that probiotic supplementation shows promising but heterogeneous effects in patients with kidney and urinary tract diseases. Across 16 clinical and observational studies involving 2,667 participants from diverse populations and countries, probiotics demonstrated potential benefits in reducing uremic toxins, improving glycemic control, lowering systemic inflammation, enhancing quality of life, and decreasing recurrence of UTI, particularly when used as adjuncts to antibiotic therapy. However, the evidence also revealed variability in outcomes, with some trials reporting neutral or adverse effects, underscoring the importance of strain selection, patient characteristics, and disease stage. Overall, probiotics may represent a safe and supportive therapeutic strategy in nephrology and urology, but further large-scale, well-designed trials are needed to clarify optimal formulations, dosing, and long-term clinical impact.

Limitations of the study

This study has several limitations. The included trials varied in design, sample size, probiotic strains, dosages, and treatment durations, which contributed to heterogeneity and limited comparability across studies. Many investigations were small, single-center, or short-term, reducing the strength and generalizability of the findings. Inconsistent reporting of outcomes, lack of standardized measures, and differences in patient populations and disease stages further complicate interpretation. Additionally, publication bias and the limited availability of high-quality randomized controlled trials may have influenced the overall conclusions.

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Authors' contribution

Conceptualization: Parham Montazeri and Farshad Namdari.
Data curation: Farshad Namdari and Hossein Dialameh.
Investigation: Parham Montazeri, Shahryar Sadeghi, and Bijan Rezakhaniha.
Methodology: Bijan Rezakhaniha and Hossein Dialameh.
Project management: Farshad Namdari.
Supervision: All authors.
Visualization: Shahryar Sadeghi and Reza Gerami.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Conflicts of interest

The authors declared no conflict of interest

Declaration of generative artificial intelligence (AI) and AI-assisted technologies in the writing process

During the preparation of this work, the authors utilized AI (Grammarly, https://app.scinito.ai/, and Copilot) to refine grammar points and language style in writing. Subsequently, the authors thoroughly reviewed and edited the content as necessary, assuming full responsibility for the accuracy and content of the publication.

Ethical issues

This investigation has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD420251273335) and Research Registry (Unique Identifying Number [UIN]: reviewregistry2068) websites. Besides, the authors have observed ethical issues (including plagiarism, data fabrication, and double publication).

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