



OPEN ACCESS

EDITED BY

Gabriella d'Ettorre,
Sapienza University of Rome, Italy

REVIEWED BY

Corina Ioana Anton,
Carol Davila University of Medicine
and Pharmacy, Romania
Kriti Vashishtha,
Manipal University Jaipur, India

*CORRESPONDENCE

Weiming He
✉ yfy0019@njucm.edu.cn

RECEIVED 09 October 2025

REVISED 11 December 2025

ACCEPTED 17 December 2025

PUBLISHED 14 January 2026

CITATION

Qian T, He Y, Yan R, Yu S, Chen Y and He W
(2026) Recurrent urinary tract infections
and psychological burden: mechanisms
and integrative perspectives.
Front. Med. 12:1721343.
doi: 10.3389/fmed.2025.1721343

COPYRIGHT

© 2026 Qian, He, Yan, Yu, Chen and He. This
is an open-access article distributed under
the terms of the [Creative Commons
Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use,
distribution or reproduction in other forums
is permitted, provided the original author(s)
and the copyright owner(s) are credited and
that the original publication in this journal is
cited, in accordance with accepted academic
practice. No use, distribution or reproduction
is permitted which does not comply with
these terms.

Recurrent urinary tract infections and psychological burden: mechanisms and integrative perspectives

Tianyang Qian^{1,2}, Yining He^{1,2}, Ruxue Yan^{1,2}, Siyao Yu^{1,2},
Yuhan Chen^{1*} and Weiming He^{1,2}

¹Affiliated Hospital of Nanjing University of Chinese Medicine, Nanjing, China, ²Nanjing University of Chinese Medicine, Nanjing, China

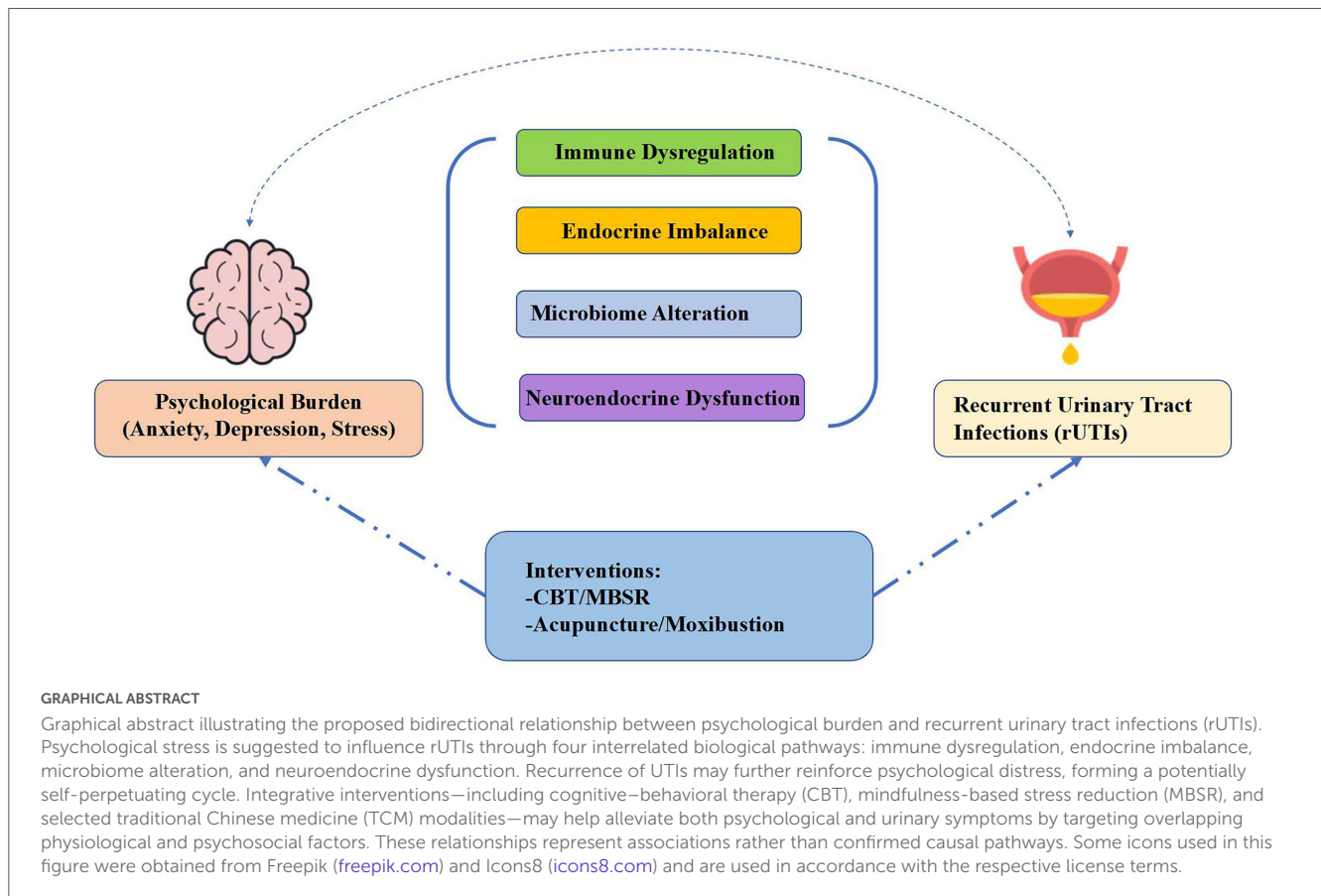
Recurrent urinary tract infections (rUTIs) remain a global health concern with significant physical and psychological impacts, particularly in women. Recent evidence indicates a strong bidirectional association between rUTIs and psychological burden, yet the underlying mechanisms remain incompletely understood. This review integrates findings from biomedical and traditional Chinese medicine (TCM) perspectives to elucidate potential pathways linking rUTIs with anxiety and depression. Four major mechanisms—immune dysregulation, endocrine imbalance, microbiome alteration, and neuroendocrine dysfunction—are proposed to explain this complex interaction. In addition, TCM conceptualizes this relationship through the theory of the “coexistence of disease and depression syndromes” emphasizing that emotional regulation is a key determinant of both urinary and systemic health. By synthesizing these insights, this narrative review underscores the importance of integrative approaches in preventing and managing rUTIs while addressing concurrent psychological distress.

KEYWORDS

endocrine system, immunity, infectious diseases, microbiome, neuroendocrine dysfunction, psychological burden, recurrent urinary tract infections (rUTIs), traditional Chinese medicine

1 Introduction

Urinary tract infections (UTIs) are among the most common infectious diseases worldwide. Approximately 60% of women experience at least one UTI during their lifetime, and 30%–40% develop recurrent urinary tract infections (rUTIs) (1). rUTIs are clinically defined as at least three UTIs within 12 months or at least two episodes within 6 months (2). In addition to the physical burden of recurrent dysuria, urgency, and frequency, rUTIs significantly impair quality of life and are often accompanied by psychological comorbidities such as anxiety and depression. Epidemiological studies indicate that anxiety disorders are among the most prevalent psychiatric conditions, with a global prevalence ranging from 2% to 29% (3). In China, 5.8% of women with UTIs were found to exhibit clinically relevant anxiety symptoms, whereas in rUTI patients, up to 68.8% experienced severe anxiety and 22.3% moderate anxiety (4, 5). These findings suggest a positive correlation between recurrence frequency and anxiety, indicating that anxiety levels increase as the rate of UTI recurrence increases.



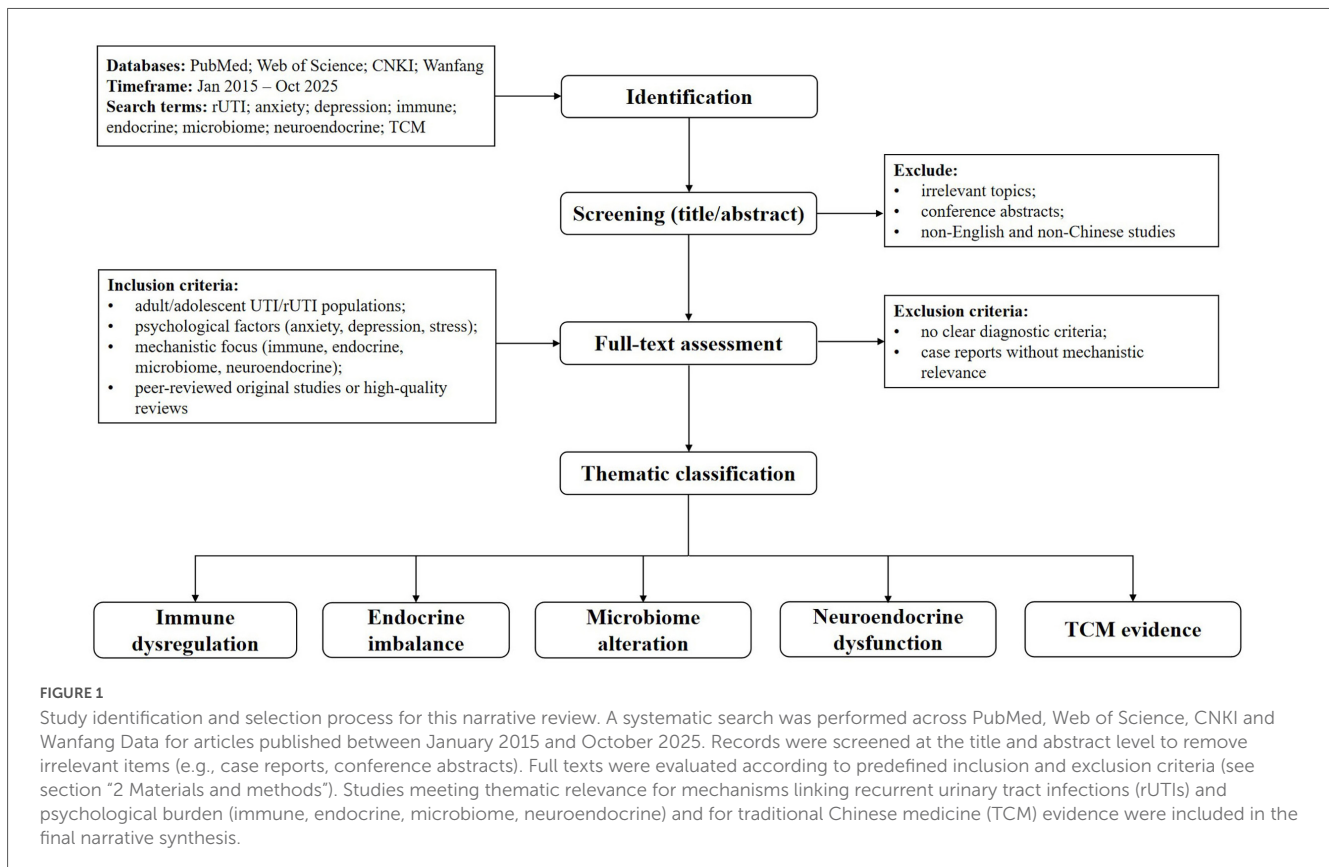
The relationship between rUTIs and psychological burden is bidirectional. Symptoms such as recurrent urinary frequency, urgency, and dysuria often disturb daily life, predisposing patients to anxiety and depression, which in turn worsen the disease course and prognosis. Additionally, mental health issues may lead to behavioral changes such as impulsivity or impaired self-care abilities, thereby increasing the risk of rUTIs (6). Although the underlying mechanisms through which rUTIs and psychological factors mutually influence each other remain unclear, current evidence suggests four potential pathways: immune dysregulation, endocrine disturbance, microbiome dysbiosis, and neuroendocrine dysfunction. These pathways affect both neurotransmitter function and urinary tract physiology, creating a feedback loop that perpetuates both infection and psychological distress. In addition to biomedical explanations, traditional Chinese medicine (TCM) provides a complementary theoretical perspective. TCM attributes rUTIs to “lin syndrome,” in which emotional disturbances are important pathogenic factors. The theory of “coexistence of diseases and depression syndromes” emphasizes that unresolved emotional distress, such as worry, anger, or fear, can disrupt the flow of qi, damage organ function, and aggravate urinary symptoms. Previous reviews have largely focused on either biomedical mechanisms or TCM interventions independently. A combined perspective may better elucidate complementary pathways linking psychological burden with rUTIs, guiding integrative clinical strategies.

Therefore, this review aims to (1) summarize current evidence regarding the physiological mechanisms linking psychological

burden with rUTIs, (2) discuss complementary insights from TCM theory and practice, and (3) propose potential integrative intervention strategies to guide future clinical research.

2 Materials and methods

To ensure comprehensive coverage of recent research, an electronic literature search was conducted in PubMed, Web of Science, CNKI, and Wanfang Data databases for studies published between January 2015 and October 2025. We searched each conceptual domain independently and reviewed articles containing any relevant combination of terms related to (1) rUTI, (2) psychological factors, (3) immune/endocrine/microbiome/neuroendocrine pathways, and (4) TCM or integrative frameworks. Domain-specific search terms included keywords such as “recurrent urinary tract infection,” “anxiety,” “depression,” “psychological stress,” “immune response,” “endocrine signaling,” “microbiome,” “neuroendocrine pathways,” “traditional Chinese medicine,” and “integrative medicine.” Approximately 3,692 records were identified across all databases. After removal of duplicates ($n \approx 1,250$), roughly 2,442 titles and abstracts were screened. Approximately 700 full-text articles were reviewed in detail, and 120 studies met inclusion criteria and were incorporated into the qualitative synthesis (Figure 1). These numbers represent approximate counts in line with narrative review reporting standards.



Inclusion criteria comprised: (1) studies involving adult or adolescent populations with UTIs or rUTIs; (2) research examining psychological factors such as anxiety, depression or stress; (3) studies reporting immune, endocrine, microbiome or neuroendocrine mechanisms; and (4) peer-reviewed original studies or high-quality reviews published between 2015 and 2025.

Exclusion criteria included: (1) case reports without mechanistic relevance; (2) studies lacking clear diagnostic criteria for UTIs; (3) conference abstracts and opinion pieces; and (4) non-English and non-Chinese studies.

Two independent reviewers screened records and extracted data on study characteristics, psychological assessments, biological markers, and mechanistic outcomes. Discrepancies were resolved by discussion. Because this is a narrative review, findings were synthesized descriptively and organized into mechanistic domains.

3 Key findings

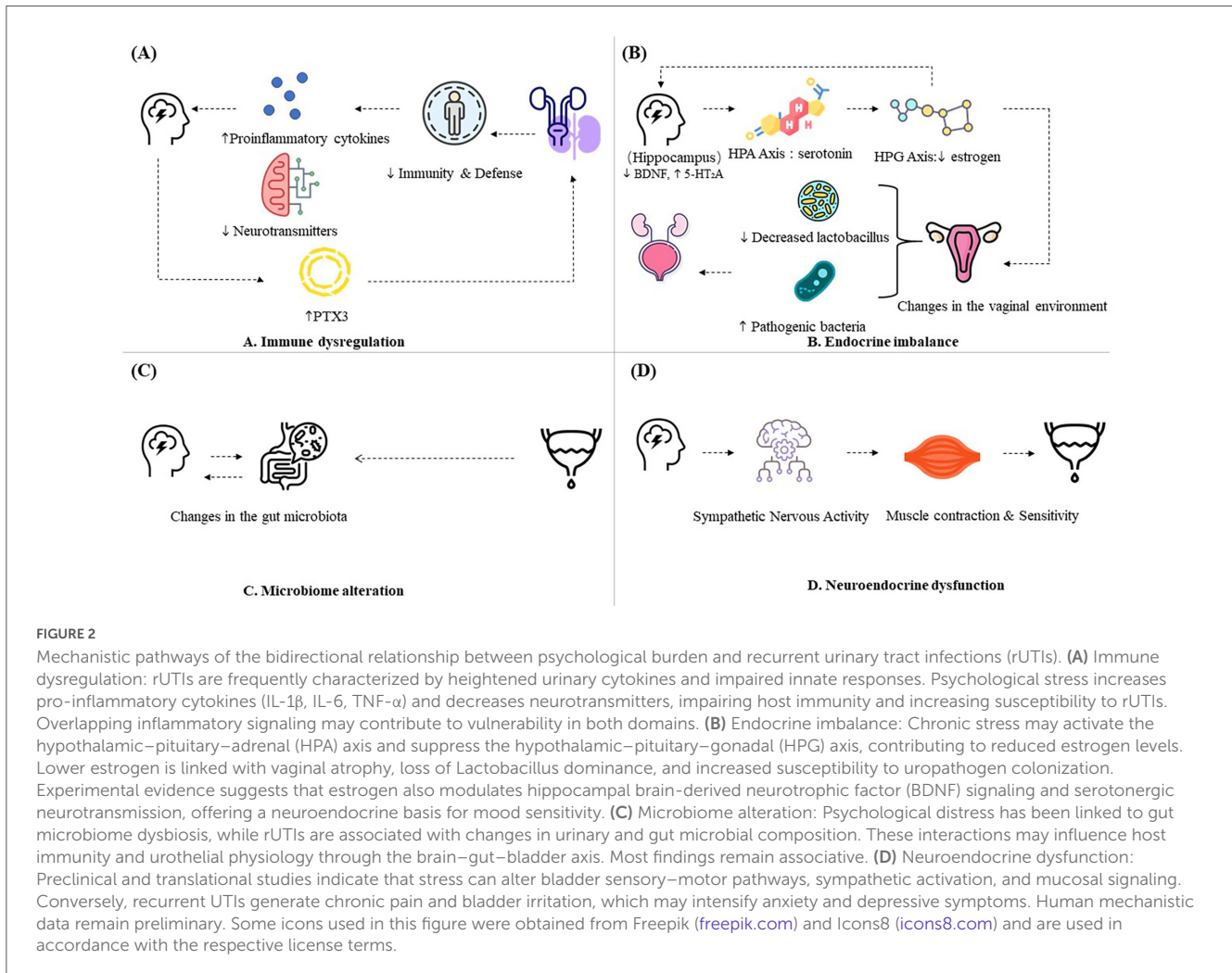
3.1 Immune dysregulation

The immune system serves as the primary defense mechanism against urinary tract pathogens, and its dysregulation plays a pivotal role in both infection susceptibility and psychological distress. Elevated urinary cytokine concentrations are closely associated with symptomatic UTIs (7). Numerous studies have reported increased levels of cytokines such as IL-1 β , IL-6, TNF α , IL-8, and CXCL-10 during episodes of UTI (8). Compared with healthy individuals, active rUTI patients present significantly elevated

concentrations of IL-1 β , IL-8, IL-18, and MCP-1 in their urine, whereas the levels of anti-inflammatory cytokines such as IL-4 and IL-13 are markedly reduced (9), indicating a persistent proinflammatory state.

Concurrently, psychiatric conditions such as anxiety and depression are characterized by systemic immune activation. During rUTIs, the levels of proinflammatory factors such as IL-6, TNF- α , and C-reactive protein (CRP) are elevated. Once these molecules cross into the central nervous system, they can suppress the secretion of neurotransmitters, including serotonin and neuropeptide Y, disrupting neural balance and contributing to emotional and cognitive impairment, thereby reinforcing a vicious cycle (10). Zheng et al. (11) analyzed available data from participants in the UK Biobank and reported that patients with depression and anxiety had higher serum levels of CRP, IL-6, and other inflammatory markers. Additionally, the correlations between serum CRP levels and depression and anxiety were generally stronger in women than in men. This overlap suggests that inflammation serves as a shared biological substrate for both rUTIs and psychological disorders.

Emerging biomarkers further support this connection. Multiple studies have confirmed that anxiety patients have lower CD4+ and CD4+/CD8+ levels than healthy individuals do, indicating weaker immune function than healthy individuals do (12). PTX3 is a key component of the innate immune system and belongs to the pentraxin superfamily. Shelton et al. (13) reported that in fibroblasts from patients with severe depression and those with a depression subtype characterized by low PKA activity, PTX3 gene expression was 3.5 times higher than that in normal controls



and non-depressed patients. Meanwhile, the expression of PTX3 in urinary epithelial cells serves as an early predictor of symptom severity and recurrence in rUTI patients. As the disease progresses, urinary PTX3 levels increase in rUTI patients compared with non-rUTI patients (14). Thus, immune dysregulation may represent the mechanistic bridge linking mental distress with recurrent infection cycles (Figure A Immune dysregulation).

3.2 Endocrine imbalance

Hormonal regulation is closely associated with both emotional stability and urinary tract health. Depression and chronic stress may reduce 5-HT receptor expression and influence the hypothalamic–pituitary–adrenal (HPA) and hypothalamic–pituitary–gonadal (HPG) axes, with potential downstream effects on estrogen levels (15). When 5-HT receptor expression is inhibited, estrogen levels correspondingly decrease.

3.2.1 Estrogen and urogenital microbiota

Estrogen plays a vital role in rUTIs by regulating the urogenital microbiome. Estrogen receptors in women are primarily distributed in the urethral submucosal vascular plexus, urethral mucosa, and bladder trigone (16). Estrogen promotes the

colonization of lactobacilli in the vaginal and urinary microbiota, thereby maintaining a protective microenvironment (17). Conversely, estrogen deficiency is thought to contribute to atrophy of the urethral and vaginal mucosa, capillary fragility, reduced secretion of protective substances and immunoglobulins, and depletion of vaginal lactobacilli. These changes allow pathogenic bacteria to colonize unchecked by lactate inhibition, thereby predisposing women to rUTIs (18).

Recent studies have demonstrated that estrogen supplementation restores lactobacillus colonization in postmenopausal women with rUTIs (19). Patients receiving vaginal estrogen experienced fewer urinary tract infections at 6 months (20).

3.2.2 Estrogen and psychological regulation

In addition to its urogenital functions, estrogen has been linked to psychological regulation. Experimental data indicate that endogenous plasma estradiol levels are positively correlated with binding to cortical 5-HT(2A) receptors (21), suggesting a potential neuroendocrine contribution to mood modulation.

Additional neurobiological evidence further strengthens the link between estrogen signaling and psychological regulation. Experimental studies show that deficiency of estrogen receptor ER β disrupts hippocampal BDNF signaling and increases 5-HT2A

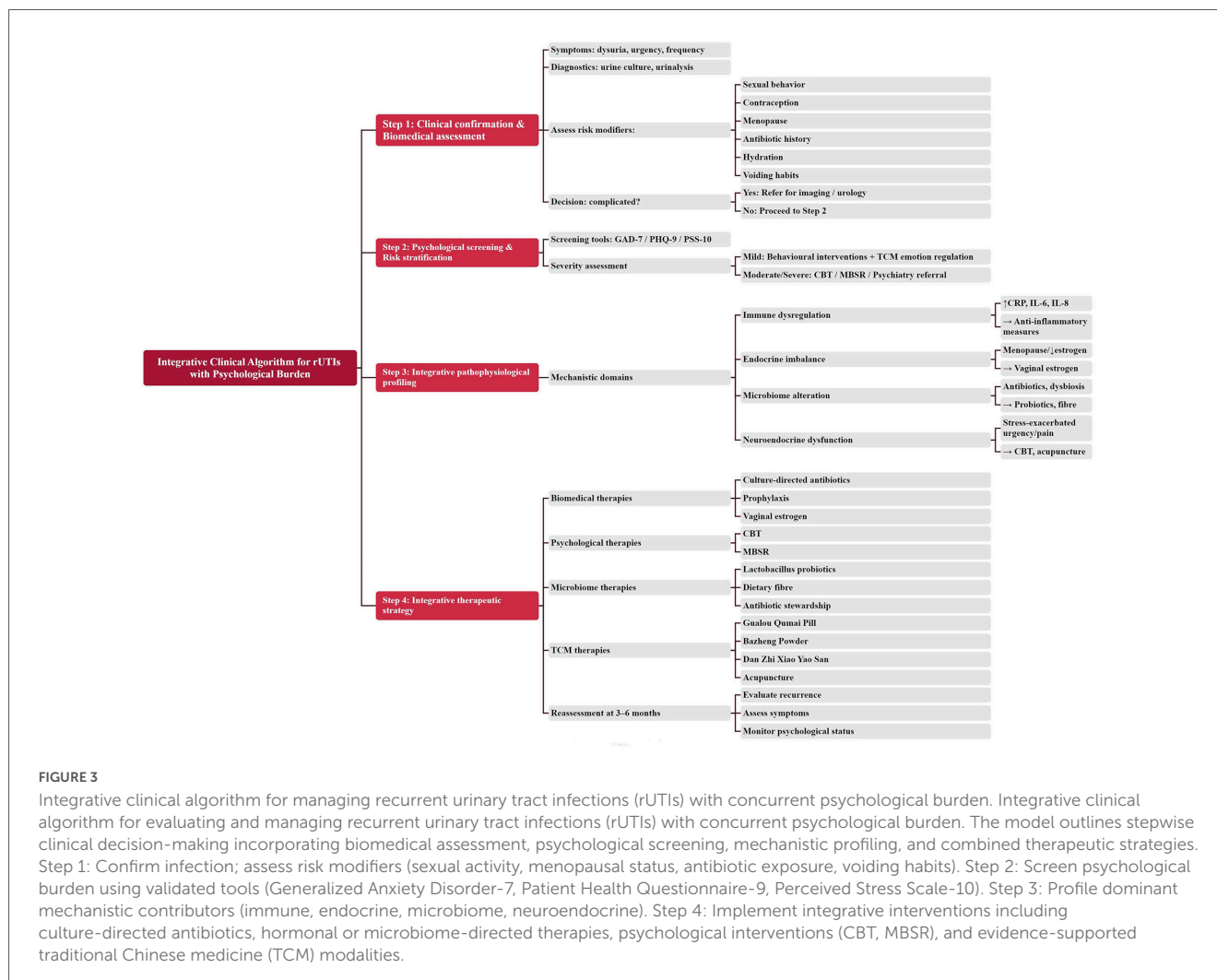


FIGURE 3

Integrative clinical algorithm for managing recurrent urinary tract infections (rUTIs) with concurrent psychological burden. Integrative clinical algorithm for evaluating and managing recurrent urinary tract infections (rUTIs) with concurrent psychological burden. The model outlines stepwise clinical decision-making incorporating biomedical assessment, psychological screening, mechanistic profiling, and combined therapeutic strategies. Step 1: Confirm infection; assess risk modifiers (sexual activity, menopausal status, antibiotic exposure, voiding habits). Step 2: Screen psychological burden using validated tools (Generalized Anxiety Disorder-7, Patient Health Questionnaire-9, Perceived Stress Scale-10). Step 3: Profile dominant mechanistic contributors (immune, endocrine, microbiome, neuroendocrine). Step 4: Implement integrative interventions including culture-directed antibiotics, hormonal or microbiome-directed therapies, psychological interventions (CBT, MBSR), and evidence-supported traditional Chinese medicine (TCM) modalities.

receptor activity, which closely involved in mood regulation (22). These findings provide a biologically plausible pathway linking estrogen deficiency with mood symptoms, although translation to human physiology remains preliminary.

Complementary mechanistic work further demonstrates that estradiol reduces 5-HT reuptake through ER β -mediated downregulation of the plasma membrane monoamine transporter (PMAT), thereby increasing synaptic serotonin availability via the MAPK/ERK signaling pathway (23). This mechanistic evidence provides a biological explanation for the mood-modulating effects of estrogen and supports a potential interaction between estrogen signaling, serotonergic pathways, and stress-responsive neural circuits, but require confirmation in human studies (Figure B Endocrine imbalance).

3.3 Microbiome alteration

The gut-brain-bladder axis provides another essential pathway connecting psychological stress with urinary health. Anxiety can induce changes in the gut microbiota, which may, in turn, affect rUTIs. Studies have shown that, compared with healthy individuals, patients with anxiety disorders present higher levels of

Escherichia coli, *Shigella*, *Clostridium*, and *Ruminococcus*, while the abundance of the dominant microbiota decreases (4). Changes in the gut microbiota can modulate susceptibility to rUTIs. Ghalavand et al. (24) confirmed that gut colonization by pathogenic strains can lead to endogenous urinary infection, based on molecular fingerprinting and genotyping of paired *Enterococcus faecalis* isolates from urine and fecal samples in symptomatic patients. Patients with rUTIs exhibit characteristics of gut microbiota dysbiosis, including reduced microbial diversity, decreased relative abundance of butyrate-producing microorganisms, and elevated plasma eosinophil chemokine-1 levels (25). Our team identified 56 metabolites associated with the *Ruminococcus* family UCG010 through Mendelian randomization. Analysis indicated that this bacterium downregulates N-acetyl-L-tyrosine levels, inhibits AhR-mediated inflammatory responses in macrophages and other cells, and subsequently promotes the development of urinary tract infections (26).

Alterations in the gut microbiota can also provide feedback and influence brain activity, as the gut microbiota can affect neurotransmitter levels, thereby influencing the central nervous system and anxiety-related behavior. The gut microbiota influences the nervous system through various mechanisms, including the production of neuroactive metabolites, modulation of the

immune system, and activation of the vagus nerve (27). For example, gut microbiota dysbiosis reduces the expression of brain-derived neurotrophic factor (BDNF) in the cerebral cortex and hippocampus, leading to central nervous system dysfunction and the onset of anxiety (28). Microbiome disruption can modulate both immune responses and neurotransmitter metabolism, perpetuating the anxiety–infection feedback loop (Figure C Microbiome alteration).

3.4 Neuroendocrine dysfunction

Experimental and clinical observations suggest that anxiety may heighten neural excitability, which in turn can influence bladder smooth muscle responsiveness, although direct causal evidence in humans remains limited (29). Experimental evidence from the water avoidance stress (WAS) model shows that chronic psychological stress can damage the bladder mucosal barrier, causing urothelial shedding, reduced tight junction protein expression, and increased epithelial permeability (30), suggesting a potential mechanistic pathway that requires further validation in human studies.

3.4.1 Central neuroinflammation

The paraventricular nucleus of the hypothalamus secretes corticotropin-releasing hormone (CRH) during stress responses. A human study examining stress and interstitial cystitis/bladder pain syndrome (IC/BPS) revealed altered CRHR expression in the bladder mucosa and submucosa, suggesting the CRH pathway may be involved in the mechanism of neurogenic inflammation in the IC/BPS bladder (31). Animal and translational studies further support the link between psychological stress and altered bladder sensory–motor function. Wood et al. demonstrated that chronic psychological stress induces marked lower urinary tract dysfunction, including shortened intervoid intervals, detrusor overactivity, and increased afferent nerve excitability. These stress-induced alterations were accompanied by enhanced sympathetic signaling and neuroinflammatory remodeling within the bladder wall, providing direct mechanistic evidence that psychological distress can heighten bladder sensitivity and amplify urinary symptoms (32). This experimental evidence aligns with clinical observations that anxiety frequently co-occurs with urgency and frequency, indicating that neuroendocrine dysregulation may be a key mediator linking psychological burden to rUTI susceptibility.

3.4.2 Bladder sensory alterations under stress

Moreover, the bladder uroepithelium itself functions as a sensory organ. The bladder uroepithelium contains numerous receptors and ion channels and can release various neurotransmitters. A dense sensory nerve network is present in the subepithelial layer of the bladder, with some terminal fibers projecting into the urothelium and others terminating between muscle fibers. Neurotransmitters released from the urothelium are thought to influence the activity of afferent nerves in the bladder and play crucial roles in the transmission of bladder stimuli to the central nervous system. In animal studies, it has been confirmed that the bladder urothelium acts as sensory receptor cells. The bladder urothelium converts bacterial lipopolysaccharide (LPS)

signals into neural signals through ATP-mediated pathways, leading to urinary frequency (33). Dysregulated neurotransmission under chronic stress may disrupt normal voiding reflexes and amplify bladder hypersensitivity, however, direct human evidence remains limited (Figure D neuroendocrine dysfunction).

In summary, existing evidence indicates that immune, endocrine, microbiome, and neuroendocrine dysregulation are potential contributors within a multifactorial framework. Understanding these mechanisms provides a foundation for exploring complementary perspectives such as TCM, which emphasizes the role of emotional balance in disease prevention and recovery (Figure 2).

4 Traditional Chinese medicine perspective

Traditional Chinese medicine provides a framework that emphasizes the bidirectional influence between emotional disturbance and physical dysfunction, which aligns with several pathways proposed in modern psychoneuroimmune models of rUTIs. TCM has attached great importance to the regulation of emotions. It is believed that joy, anger, anxiety, thinking, sorrow, fear and fright are important causes of physical health problems. This is also known as the “internal injury caused by seven emotions,” and these emotions injure the five organs and cause disordered movement of qi. Zhu Danxi once said: If qi and blood are harmonized, all diseases will not arise; once you are depressed, you will be prone to many diseases. Therefore melancholy is the cause of most illnesses (34). Stagnation or depression of qi obstructs the normal transmission of fluids, resulting in bladder dysfunction. In modern society, individuals are often exposed to heavy social and psychological stress, which commonly leads to qi stagnation. In addition to depression caused by preexisting illness, illness itself can also provoke emotional depression, further impairing health. When the five qi are stagnant, all kinds of illnesses arise; this is depression caused by illness. rUTIs have a prolonged course, with a persistent and chronic nature that fails to resolve. Patients often endure repeated episodes of painful, urgent, or difficult urination, and in some cases, urinary incontinence, all of which severely impair quality of life. They are constantly anxious and fearful, with the disease and emotions mutually influencing each other, thereby triggering depression, such as anxiety and depression, and forming a vicious cycle of “disease-depression-disease” that repeatedly recurs. Although these terms do not directly correspond to measurable biomedical indices, their functional implications align with contemporary findings on stress-related neuroendocrine and inflammatory dysregulation.

To integrate TCM theory more directly with biomedical mechanisms, we mapped classical TCM syndromes onto corresponding physiological domains (Table 1). This mapping clarifies where conceptual alignment exists and where biomedical evidence remains preliminary. For instance, the TCM concept of liver-qi stagnation parallels chronic activation of the HPA axis and elevations in cortisol and proinflammatory cytokines observed in stress-related disorders. Although the physiological substrates differ, both frameworks emphasize impaired emotional regulation and sustained inflammatory signaling as contributors

TABLE 1 Mapping of traditional Chinese medicine (TCM) syndromes to biomedical correlates and supporting evidence.

TCM syndrome	Biomedical correlate	Supporting evidence
Liver-qi stagnation (emotional constraint, impaired flow of qi and fluids)	HPA-axis activation; chronic low-grade inflammation	Elevated cortisol and cytokines in stress-related disorders; neuroimmune links to urinary symptoms reported in stress-related bladder disorders
Damp-heat in the bladder	Microbiome dysbiosis; chronic mucosal inflammation	Reduced Lactobacillus, increased Gram-negative organisms; elevated IL-6, IL-8 in rUTIs
Spleen deficiency with dampness	Gut–brain axis disturbance; impaired immune tolerance	Altered short-chain fatty acid–producing bacteria; weakened mucosal immunity
Kidney and liver yin deficiency	Estrogen deficiency; vaginal atrophy; decreased microbiota stability	Lower estrogen in postmenopausal rUTIs; reduced Lactobacillus diversity
Disease–depression coexistence	Bidirectional psychosomatic feedback; neuroendocrine hypersensitivity	Associations between anxiety, pain sensitivity, and bladder sensory remodeling

Mapping of TCM syndromes to biomedical correlates and supporting evidence. These associations represent conceptual parallels rather than one-to-one physiological equivalence. Evidence levels range from clinical (immune and estrogen pathways) to preliminary (neuroendocrine–TCM intersections).

to urinary dysfunction. The TCM pattern of damp-heat in the bladder aligns with recurrent mucosal inflammation, reduced Lactobacillus stability, and increased Gram-negative colonization in rUTIs. This correspondence is supported by moderate clinical evidence and microbiome studies, although strain-level variability limits strong conclusions. Spleen deficiency with dampness maps onto impaired gut–brain axis integrity and weaker mucosal immunity; this is supported by emerging evidence demonstrating reduced short-chain fatty acid–producing bacteria and increased intestinal permeability in rUTI patients. However, findings remain preliminary. Kidney and liver yin deficiency corresponds to hypoestrogenic states and reduced vaginal microbiota stability, particularly in postmenopausal women. This mapping is supported by relatively consistent clinical evidence for estrogen deficiency as a risk factor for rUTIs, although TCM conceptualization focuses on systemic depletion rather than hormonal pathways.

Recent scientific research has begun to provide empirical support for these traditional insights. Clinical studies show that Gualou Qumai Pill can enhance cellular immunity and reduce recurrence rates in rUTI patients (35), while Bazheng powder has been demonstrated to alleviate bladder inflammation in animal experiments (36). Experimental studies indicate that Dan Zhi Xiao Yao San can modulate M1/M2 microglial polarization in the hippocampus and ameliorate stress-induced anxiety-like behaviors (37). Acupuncture and moxibustion are widely used to relieve emotional disorders and regulate systemic balance. On the one hand, owing to its wide range of therapeutic effects, moxibustion, an external therapy in traditional Chinese medicine, has been used to treat emotional disorders such as anxiety and depression. Moreover, experiments have shown that moxibustion smoke has a good inhibitory effect on *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, and *Pseudomonas aeruginosa* (38). These findings bridge the psychological and physiological dimensions of rUTI management, showing that TCM interventions can impact both emotional regulation and urinary tract health.

Together, these mapped relationships show that TCM and biomedical perspectives are not parallel narratives but mutually informative frameworks. TCM emphasizes systemic pattern recognition and emotional–somatic coupling, while biomedical pathways specify molecular and cellular processes. When integrated, they highlight convergent mechanisms—such

as stress-induced immune modulation and chronic inflammatory states—while acknowledging conceptual mismatch where direct physiological equivalence is not possible. This structured synthesis strengthens the interpretative model for rUTIs and supports the rationale for combining emotional regulation, immunomodulatory strategies, and microbiome-targeted interventions in clinical practice. By mapping TCM syndromes to biomedical correlates and identifying where evidence is strong, suggestive, or divergent, an integrated conceptual model can be formed that addresses both emotional and urinary tract dysfunction. This synthesis also highlights therapeutic implications: combining TCM herbal formulas, emotional regulation therapies, and standard antimicrobial or behavioral strategies may offer synergistic benefits for patients with recurrent infections.

5 Discussion

5.1 Key findings and mechanistic insights

This review highlights four primary biomedical pathways—immune dysregulation, endocrine imbalance, microbiome alteration, and neuroendocrine dysfunction—which may jointly mediate the bidirectional relationship between rUTIs and psychological burden. These mechanisms demonstrate the reciprocal relationship between mental health and infection recurrence. In parallel, TCM theories provide a complementary perspective, emphasizing the importance of emotional regulation and systemic balance in disease prevention and recovery.

Recent multidisciplinary studies increasingly support the intertwined nature of psychological distress and urinary tract health. Martin et al. (39) identified elevated levels of IL-6 and CRP are observed in patients with lower urinary tract symptoms accompanied by anxiety and depression. Meanwhile, Urakami et al. (40), Worby et al. (25) explored the existence of the gut–bladder axis, underscoring the significance of microbiome diversity reduction in UTI susceptibility. In addition, the psychosocial impact of recurrent urogenital infections described by Thomas-White et al. (41) reinforces the need to account for the psychological dimension in rUTI management. These studies align with our integrative framework linking psychological, microbial

and urinary tract health. However, the evidence remains limited in several areas, including longitudinal research linking anxiety or depression directly to rUTI recurrence, and mechanistic trials on TCM interventions.

5.2 Evidence quality and methodological limitations

Although multiple biological pathways have been proposed to explain the relationship between psychological burden and rUTIs, the strength and consistency of the existing evidence vary substantially across domains. Immune and inflammatory pathways are supported by relatively robust human data, including large cohort studies and clinically measured cytokine profiles, which suggest associations between systemic inflammation, immune activation, and urinary tract symptoms. A recent comprehensive review on lower urinary tract inflammation and infection synthesized mechanistic and clinical findings showing that elevated urinary cytokines, epithelial barrier disruption, and impaired innate defense responses are consistently associated with rUTI susceptibility (42). However, the interpretation of these findings is constrained by several methodological issues. Most studies adopt cross-sectional or observational designs and rarely evaluate psychological stress, immune markers, and UTI outcomes concurrently, limiting the ability to test a psychoneuroimmune causal pathway. Heterogeneity in sampling timing (e.g., during acute infection, early recovery, or asymptomatic periods), variation in rUTI definitions, and demographic differences further complicate comparisons across studies. For instance, although increased IL-6 and IL-8 levels are often reported during active UTIs, a clinical study demonstrated that serum and urinary IL-6/IL-8 levels did not reliably distinguish upper from lower urinary tract infections in children (43). Evidence from biomarker research in pediatric UTI shows that urinary IL-9, IL-2, IL-8, and NGAL can distinguish children with true UTI from those with pyuria but no infection, whereas serum markers show lower accuracy (44). This discrepancy underscores how biomarker performance varies by sample type and may contribute to inconsistent immune profiles across rUTI studies.

Microbiome findings show even greater heterogeneity. Although several reports indicate reduced microbial diversity and depletion of butyrate-producing taxa in rUTI patients, strain-level results vary widely due to sequencing platform differences, antibiotic exposure, dietary variability, and inconsistent diagnostic criteria. Recent longitudinal metagenomic work found that women with rUTIs exhibit reduced gut microbial richness and significant depletion of butyrate-producing bacterial taxa compared with non-rUTI controls. However, the same study did not observe consistent differences in gut carriage of uropathogenic *Escherichia coli* between groups, suggesting that microbial composition alone may not fully explain recurrence (25). Instead, host-microbiome interaction and immune responsiveness may be more relevant. These inconsistencies indicate that microbiome-mediated mechanisms are promising but remain insufficiently validated. Another pilot study reported that female patients with recurrent cystitis have increased intestinal permeability and reduced gut microbial diversity compared to healthy controls,

implying a compromised gut barrier and dysbiosis in recurrent infection cases (45). Nonetheless, small sample size, comorbid gastrointestinal conditions, and heterogeneous patient selection limit the generalizability of these findings. Collectively, while data from gut microbiome analyses provide a biologically plausible basis for a gut-bladder axis contributing to rUTIs, existing evidence remains preliminary and subject to methodological heterogeneity. Larger, longitudinal, and multi-omics studies are required to validate causality and identify specific microbial or host biomarkers predictive of infection recurrence.

Evidence for endocrine and neuroendocrine pathways relies heavily on animal models or small human studies. The interactions between estrogen deficiency, HPA/HPG axis dysregulation, serotonergic signaling, and bladder function are biologically plausible, but direct human causal data are sparse. Many effects—such as ER β -mediated modulation of BDNF and PMAT—have been demonstrated primarily in rodents and require caution when extrapolated to clinical populations.

Overall, immune dysregulation is supported by relatively strong human evidence; microbiome alteration and endocrine pathways are supported by moderate and methodologically variable data; and neuroendocrine remodeling remains largely mechanistic or hypothesis-level. These differences should temper interpretation of the integrative model and highlight the need for longitudinal, multi-omics, and mechanistic clinical trials to strengthen causal inference.

5.3 Risk modifiers beyond psychological burden

Beyond psychological factors, several well-established contributors influence rUTI recurrence, including sexual activity, contraceptive methods, menopausal status, behavioral factors such as hydration and voiding habits, and antimicrobial resistance patterns. Although these variables were not the focus of this mechanistic review, they interact with psychological burden and should be considered when interpreting the current evidence base.

5.4 Clinical implications and integrative management

Given the multifaceted nature of the rUTI-psychological burden relationship, therapeutic strategies should concurrently target physiological and psychological domains. Psychological interventions such as cognitive-behavioral therapy (CBT) and mindfulness-based stress reduction (MBSR) can reduce anxiety and modulate immune responses, thereby potentially decreasing rUTI recurrence (46–51). From a TCM perspective, herbal formulas addressing damp-heat and emotional stagnation, acupuncture and moxibustion aimed at autonomic balance and qi flow, offer complementary benefits. Emerging experimental evidence, for example on formulas such as Gualou Qumai Pill and Bazheng powder indicates modulation of inflammatory cytokines and gut or bladder microbiota. Xu et al. (52) showed that Er Ding Er Xian combined with moxibustion significantly reduced recurrence rates

and improved anxiety scores in clinical rUTI patients. However, high-quality clinical trials remain scarce. An integrative model combining antimicrobial measures, lifestyle and psychological support, and evidence-based TCM may provide the best outcomes in reducing recurrence, improving quality of life and addressing mental health comorbidities.

Given the multidimensional relationship between rUTIs and psychological burden, a structured integrative clinical algorithm is essential. Figure 3 presents a practical model combining biomedical assessment, psychological evaluation, risk stratification, microbiome-directed strategies, and evidence-supported TCM interventions.

5.4.1 Step 1. Clinical confirmation and biomedical assessment

Objectives: confirm true infection, identify recurrence patterns, and rule out structural/urological abnormalities.

Key components:

- Symptom evaluation: dysuria, urgency, frequency, suprapubic pain.
- Diagnostic tests:
 - Urine culture (>105 CFU/mL or symptomatic low-count bacteriuria),
 - Urinalysis (leukocyte esterase, nitrites),
 - Postmenopausal evaluation of urogenital atrophy.
- Risk modifiers assessment:
 - Sexual behavior and post-coital exposure,
 - spermicide/diaphragm use,
 - menopausal status and hormone deficiency,
 - Antibiotic history and resistance patterns,
 - Voiding habits, hydration, constipation.

Decision node:

- If complicated UTI suspected (structural abnormality, stones, diabetes): refer for urologic imaging.
- If uncomplicated rUTI confirmed → proceed to Step 2.

5.4.2 Step 2. Psychological screening and psychosocial risk stratification

Objectives: quantify anxiety, depression, and stress levels; determine whether psychological burden is contributing to recurrence.

Recommended tools (validated):

- GAD-7 for anxiety
- PHQ-9 for depression
- PSS-10 for perceived stress
- Optional: HADS, STAI

Decision node:

- Moderate–severe symptoms: refer to CBT, MBSR, or psychiatry as needed.

- Mild symptoms: integrate behavioral interventions + TCM emotional regulation strategies.

5.4.3 Step 3. Integrative pathophysiological profiling

Objective: identify dominant mechanistic contributors (immune, endocrine, microbiome, neuroendocrine).

Suggested indicators:

- Immune dysregulation: elevated CRP, IL-6, IL-8; frequent inflammatory flares.
- Endocrine imbalance: menopausal status, low estrogen symptoms.
- Microbiome alteration: history of repeated antibiotics, constipation, dysbiosis symptoms.
- Neuroendocrine dysfunction: urgency worsened by stress; pelvic pain; hyperarousal.

Example interventions:

- Immune dysregulation: anti-inflammatory lifestyle strategies, TCM formulas for damp-heat.
- Endocrine imbalance: local vaginal estrogen; TCM formulas harmonizing liver–kidney.
- Microbiome alteration: probiotic lactobacilli, dietary fiber, TCM spleen–qi strengthening herbs.
- Neuroendocrine dysfunction: CBT; acupuncture; neuromodulation.

5.4.4 Step 4. Integrative therapeutic strategy

Biomedical therapy:

- Targeted antibiotics based on culture,
- Prophylactic options when indicated,
- Vaginal estrogen for hypoestrogenic women.

Psychological interventions:

- CBT, ACT (acceptance-based therapy),
- Mindfulness-based stress reduction (MBSR).

Microbiome-directed therapy:

- Lactobacillus probiotics,
- Increased dietary fibre,
- Avoidance of unnecessary antibiotics.

TCM-based interventions (evidence-supported):

- Herbal formulas
 - Gualou Qumai Pill (immune modulation, reduction of recurrence),
 - Bazheng powder (reducing bladder inflammation),
 - Dan Zhi Xiao Yao San (emotional regulation, microglial modulation).

- Acupuncture/moxibustion to improve autonomic balance and reduce anxiety.

Decision node:

- Reassess at 3–6 months → determine recurrence reduction, symptom improvement, and psychological stabilization.

5.5 Academic contribution and future directions

This review contributes academically by bridging conventional biomedical pathways with TCM theories, thereby offering a novel integrative mechanism model for rUTIs and psychological burden. Unlike previous reviews focused solely on microbial resistance or prophylaxis, our approach emphasizes the interplay of immune, endocrine, microbial and neuroendocrine systems within a psychosomatic and integrative medicine framework. This enriched perspective may stimulate future interdisciplinary research and inform holistic clinical strategies.

Future research should prioritize longitudinal cohort studies, mechanistic trials integrating psychoneuroimmunology and microbiome analysis, and high-quality RCTs assessing TCM plus psychological care in rUTI populations. Additionally, neuroimaging or metabolomic studies may clarify how emotional regulation therapies influence immune and urinary tract biology.

6 Conclusion

Recurrent urinary tract infections and psychological distress are interdependent conditions connected through immune, endocrine, microbiological, and neuroendocrine mechanisms. This review emphasizes the necessity of adopting a multidimensional treatment model that concurrently addresses mental health and urinary tract physiology.

From both biomedical and TCM perspectives, emotional balance and systemic harmony are essential for preventing disease recurrence. Future clinical practice should shift toward integrative models that combine pharmacological therapy, psychological interventions, and evidence-based TCM modalities. Such holistic strategies may ultimately reduce recurrence rates, improve quality of life, and enhance resilience against both infection and psychological stress.

References

1. Kwok M, McGeorge S, Mayer-Coverdale J, Graves B, Paterson DL, Harris PNA, et al. Guideline of guidelines: management of recurrent urinary tract infections in women. *BJU Int.* (2022) 130(Suppl 3):11–22. doi: 10.1111/bju.15756
2. Cai T. Recurrent uncomplicated urinary tract infections: definitions and risk factors. *GMS Infect Dis.* (2021) 9:Doc03. doi: 10.3205/id000072
3. Bonomi RE, Pietrzak R, Cosgrove KP. Neuroglia in anxiety disorders. *Handb Clin Neurol.* (2025) 210:335–46. doi: 10.1016/B978-0-443-19102-2.00008-9
4. Jiang HY, Zhang X, Yu ZH, Zhang Z, Deng M, Zhao JH, et al. Altered gut microbiota profile in patients with generalized anxiety disorder. *J Psychiatr Res.* (2018) 104:130–6. doi: 10.1016/j.jpsychires.2018.07.007
5. Jo SB, Kim HJ, Ahn ST, Oh MM. Level of anxiety shows a positive correlation with the frequency of acute cystitis recurrence in women. *Int Neurourol J.* (2024) 28:156–61. doi: 10.5213/inj.2448096.048
6. Dachew BA, Scott JG, Alati R. Gestational urinary tract infections and the risk of antenatal and postnatal depressive and anxiety symptoms: a longitudinal population-based study. *J Psychosom Res.* (2021) 150:110600. doi: 10.1016/j.jpsychores.2021.110600
7. Armbruster CE, Smith SN, Mody L, Mobley HLT. Urine cytokine and chemokine levels predict urinary tract infection severity independent of uropathogen, urine bacterial burden, host genetics, and host age. *Infect Immun.* (2018) 86:e327–318. doi: 10.1128/IAI.00327-18

Author contributions

TQ: Writing – review & editing, Writing – original draft. YH: Writing – review & editing. RY: Writing – review & editing. SY: Writing – review & editing. YC: Writing – review & editing. WH: Writing – review & editing.

Funding

The author(s) declared that financial support was received for this work and/or its publication. This work was supported by the Jiangsu Provincial Medical Innovation Center (No. 82575032) and the Jiangsu Maternal and Child Health Association Research Project (Grant No. FYX202308).

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

8. Mansfield KJ, Chen Z, Moore KH, Grundy L. Urinary tract infection in overactive bladder: an update on pathophysiological mechanisms. *Front Physiol.* (2022) 13:886782. doi: 10.3389/fphys.2022.886782
9. Ebrahimzadeh T, Basu U, Lutz KC, Gadhvi J, Komarovskiy JV, Li Q, et al. Inflammatory markers for improved recurrent UTI diagnosis in postmenopausal women. *Life Sci Alliance.* (2024) 7:e202302323. doi: 10.26508/lsa.202302323
10. Shi H, Wu Y, Ma Y. The relationship between anxiety level and memory function, stress level in patients with first-episode generalized anxiety disorder. *J Int Psychiatry.* (2024) 51:834–47. doi: 10.13479/j.cnki.jip.2024.03.050
11. Ye Z, Kappelmann N, Moser S, Davey Smith G, Burgess S, Jones PB, et al. Role of inflammation in depression and anxiety: tests for disorder specificity, linearity and potential causality of association in the UK Biobank. *EClinicalMedicine.* (2021) 38:100992. doi: 10.1016/j.eclinm.2021.100992
12. Pardeshi GN, Ali N, Shirasath KR, Goyal SN, Nakhate KT, Awathale SN. Inhibition of TRPM3 channels in the medial prefrontal cortex mitigates OCD symptoms following traumatic brain injury. *Inflammopharmacology.* (2017) 33:1223–5. doi: 10.1007/s10787-025-01763-5
13. Shelton RC, Liang S, Liang P, Chakrabarti A, Manier DH, Sulser F. Differential expression of pentraxin 3 in fibroblasts from patients with major depression. *Neuropsychopharmacology.* (2004) 29:126–32. doi: 10.1038/sj.npp.1300307
14. Li Z, Xu Y, Wang Q, Yuan G, Shu J, Liu S, et al. The natural immune molecules urinary Tamm-Horsfall protein and pentraxin 3 as predictors for recurrent urinary tract infection severity: a single-center self-control study. *Ren Fail.* (2025) 47:2449574. doi: 10.1080/0886022X.2024.2449574
15. Zhang X, Ma L, Li J, Zhang W, Xie Y, Wang Y. Mental health and lower urinary tract symptoms: results from the NHANES and Mendelian randomization study. *J Psychosom Res.* (2024) 178:1115599. doi: 10.1016/j.jpsychores.2024.1115599
16. Lü D, Shuang W. Advances in the prevention and treatment of lower urinary tract symptoms in postmenopausal women with genitourinary syndrome. *Prog Obstet Gynecol.* (2022) 31:700–3. doi: 10.13283/j.cnki.xdfckjz.2022.09.011
17. Neugent ML, Kumar A, Hulyalkar NV, Lutz KC, Nguyen VH, Fuentes JL, et al. Recurrent urinary tract infection and estrogen shape the taxonomic ecology and function of the postmenopausal urogenital microbiome. *Cell Rep Med.* (2022) 3:100753. doi: 10.1016/j.xcrm.2022.100753
18. Chen, F, Li M, Zhang A. Effect of low dose Estrogen combined with antibiotics in the treatment of recurrent urinary tract infection in postmenopausal women. *China. Modern Med.* (2019) 26:129–35.
19. Jung CE, Estaki M, Chopyk J, Taylor BC, Gonzalez A, McDonald D, et al. Impact of vaginal estrogen on the urobiome in postmenopausal women with recurrent urinary tract infection. *Female Pelvic Med Reconstr Surg.* (2022) 28:20–6. doi: 10.1097/SPV.0000000000001051
20. Ferrante KL, Wasenda EJ, Jung CE, Adams-Piper ER, Lukacz ES. Vaginal Estrogen for the prevention of recurrent urinary tract infection in postmenopausal women: a randomized clinical trial. *Female Pelvic Med Reconstr Surg.* (2021) 27:112–7. doi: 10.1097/SPV.0000000000000749
21. Hu J, Zhou B, Li Y, Deng Y, He Q, Ye J, et al. The interaction between estradiol change and the serotonin transporter gene (5-HTTLPR) polymorphism is associated with postpartum depressive symptoms. *Psychiatr Genet.* (2019) 29:97–102. doi: 10.1097/YPG.0000000000000222
22. Chhibber A, Woody SK, Karim Rumi MA, Soares MJ, Zhao L. Estrogen receptor β deficiency impairs BDNF-5-HT_{2A} signaling in the hippocampus of female brain: a possible mechanism for menopausal depression. *Psychoneuroendocrinology.* (2017) 82:107–16. doi: 10.1016/j.psyneuen.2017.05.016
23. Gu Y, Zhang N, Zhu S, Lu S, Jiang H, Zhou H. Estradiol reduced 5-HT reuptake by downregulating the gene expression of Plasma Membrane Monoamine Transporter (PMAT, Slc29a4) through estrogen receptor β and the MAPK/ERK signaling pathway. *Eur J Pharmacol.* (2022) 924:174939. doi: 10.1016/j.ejphar.2022.174939
24. Ghalavand Z, Alebouyeh M, Ghanati K, Azimi L, Rashidan M. Genetic relatedness of the *Enterococcus faecalis* isolates in stool and urine samples of patients with community-acquired urinary tract infection. *Gut Pathog.* (2020) 12:42. doi: 10.1186/s13099-020-00380-7
25. Worby CJ, Schreiber HL, Straub TJ, van Dijk LR, Bronson RA, Olson BS, et al. Longitudinal multi-omics analyses link gut microbiome dysbiosis with recurrent urinary tract infections in women. *Nat Microbiol.* (2022) 7:630–9. doi: 10.1038/s41564-022-01107-x
26. He Y, Han C, Li C, Yin X, Wang J, Gu L, et al. Role of N-acetylkynurenine in mediating the effect of gut microbiota on urinary tract infection: a Mendelian randomization study. *Front Microbiol.* (2024) 15:1384095. doi: 10.3389/fmicb.2024.1384095
27. Shen C, Fang M, Zhang X, Zhu Z, Chen J, Tang G. Causal effects of gut microbiota on risk of overactive bladder symptoms: a two-sample Mendelian randomization study. *Front Microbiol.* (2024) 15:1459634. doi: 10.3389/fmicb.2024.1459634
28. Fan W, Jiang T, Wang Y, Zhang G, Lu Y, Liu M, et al. Fufang Kangjiaolv capsules treat anxiety in rat model of chronic restraint stress via microbiota-gut-brain axis. *Chin J Exp Tradit Med Formulae.* (2025) 31:95–107. doi: 10.13422/j.cnki.syfx.20241803
29. West EG, Sellers DJ, Chess-Williams R, McDermott C. Bladder overactivity induced by psychological stress in female mice is associated with enhanced bladder contractility. *Life Sci.* (2021) 265:118735. doi: 10.1016/j.lfs.2020.118735
30. Saito T, Hitchens TK, Foley LM, Singh N, Mizoguchi S, Kurobe M, et al. Functional and histologic imaging of urinary bladder wall after exposure to psychological stress and protamine sulfate. *Sci Rep.* (2021) 11:19440. doi: 10.1038/s41598-021-98504-9
31. Jhang JF, Birder LA, Jiang YH, Hsu YH, Ho HC, Kuo HC. Dysregulation of bladder corticotropin-releasing hormone receptor in the pathogenesis of human interstitial cystitis/bladder pain syndrome. *Sci Rep.* (2019) 9:19169. doi: 10.1038/s41598-019-55584-y
32. Gao Y, Rodriguez LV. The effect of chronic psychological stress on lower urinary tract function: an animal model perspective. *Front Physiol.* (2022) 13:818993. doi: 10.3389/fphys.2022.818993
33. Ueda N, Kondo M, Takezawa K, Kiuchi H, Sekii Y, Inagaki Y, et al. Bladder urothelium converts bacterial lipopolysaccharide information into neural signaling via an ATP-mediated pathway to enhance the micturition reflex for rapid defense. *Sci Rep.* (2020) 10:21167. doi: 10.1038/s41598-020-78398-9
34. Cui S. *The Translation of Implicit Information in the Texts on Traditional Chinese Medicine - A Practical Report on Chinese-English Translation of Don't Get Angry: Most Diseases Are Caused by Anger (Chapters 1 to 2)*. Dalian: Dalian University of Foreign Languages (2024). doi: 10.26993/d.cnki.gslcy.2024.000320
35. Zheng G, Meng Y, Shi Y, Tang L, Liu B. Clinical observation on modified Gualou Qumai Pill for recurrent urinary tract infections. *Chin J Integr Nephrol.* (2017) 18:520–2.
36. Xi H, Li X, Jiang X, Li J, Ma Z, Li X. Improvement effects and mechanism of Bazheng powder on chronic urinary tract infection in rats. *Chin Pharm.* (2025) 36:2525–30.
37. Gong RR, Lu DC, Chen S, Gao LX, Wei YT, Zhang QW, et al. Regulatory effects of dan zhi xiao yao san on microglial activation in anxious rats. *Shizhen Guoyi Guoyao* (2025) 1–6.
38. Yu Q, Bi X, Zheng X, Tang J. Application rules on high-dose moxibustion based on ancient Chinese medical literature. *J Tradit Chin Med Lit.* (2024) 42:49–52.
39. Martin S, Vincent A, Taylor AW, Atlantis E, Jenkins A, Januszewski A, et al. Lower urinary tract symptoms, depression, anxiety and systemic inflammatory factors in men: a population-based cohort study. *PLoS One.* (2015) 10:e0137903. doi: 10.1371/journal.pone.0137903
40. Urakami C, Yamanouchi S, Kimata T, Tsuji S, Akagawa S, Kino J, et al. Abnormal development of microbiota may be a risk factor for febrile urinary tract infection in infancy. *Microorganisms.* (2023) 11:2574. doi: 10.3390/microorganisms11102574
41. Thomas-White K, Navarro P, Wever F, King L, Dillard LR, Krapf J. Psychosocial impact of recurrent urogenital infections: a review. *Womens Health.* (2023) 19:17455057231216537. doi: 10.1177/17455057231216537
42. Dickson K, Zhou J, Lehmann C. Lower urinary tract inflammation and infection: key microbiological and immunological aspects. *J Clin Med.* (2024) 13:315. doi: 10.3390/jcm13020315
43. Al Rushood M, Al-Eisa A, Al-Attiyah R. Serum and urine interleukin-6 and interleukin-8 levels do not differentiate acute pyelonephritis from lower urinary tract infections in children. *J Inflamm Res.* (2020) 13:789–97. doi: 10.2147/JIR.S275570
44. Shaikh N, Martin JM, Hoberman A, Skae M, Milkovich L, McElheny C, et al. Biomarkers that differentiate false positive urinalyses from true urinary tract infection. *Pediatr Nephrol.* (2020) 35:321–9. doi: 10.1007/s00467-019-04403-7
45. Graziani C, Laterza L, Talocco C, Pizzoferrato M, Di Simone N, D'ippolito S, et al. Intestinal permeability and dysbiosis in female patients with recurrent cystitis: a pilot study. *J Pers Med.* (2022) 12:1005. doi: 10.3390/jpm12061005
46. Croghan TW, Tomlin M, Pescosolido BA, Schnittker J, Martin J, Lubell K, et al. American attitudes toward and willingness to use psychiatric medications. *J Nerv Ment Dis.* (2003) 191:166–74. doi: 10.1097/01.NMD.0000054933.52571.CA
47. Bai H. Combining music therapy with cognitive behavioral therapy for the treatment of anxiety disorders. *Cult Industry.* (2024) 27:4–6.
48. Liu J, Wang Y. The effect of cognitive behavioral therapy on adverse mood and immune function in patients with rectal cancer undergoing radiotherapy and chemotherapy chemoradiotherapy. *Int J Psychiatry.* (2023) 50:860–3. doi: 10.13479/j.cnki.jip.2023.04.046
49. Huang D, Zhang J, Zheng S, Zhou J, Lü J. Clinical observation on the therapeutic effect of cognitive behavioral therapy combined with family walking rehabilitation exercise on elderly patients with heart failure accompanied by anxiety and depression. *Cardio-cerebrovascular Dis Prevent Treat.* (2024) 24:44–8.
50. Sipe WE, Eisendrath SJ. Mindfulness-based cognitive therapy: theory and practice. *Can J Psychiatry.* (2012) 57:63–9. doi: 10.1177/070674371205700202
51. Hoge EA, Bui E, Palitz SA, Schwarz NR, Owens ME, Johnston JM, et al. The effect of mindfulness meditation training on biological acute stress responses in generalized anxiety disorder. *Psychiatry Res.* (2018) 262:328–32. doi: 10.1016/j.psychres.2017.01.006
52. Xu D, Miao H. Erding erxian recipe combined with moxibustion in the treatment of 61 cases with chronic recurrent urinary tract infection. *Shanghai Med Pharm J.* (2022) 43:31–5.