Zhang X, et al., J Altern Complement Integr Med 2024, 10: 529
DOI: 10.24966/ACIM-7562/100529

HSOA Journal of
Alternative, Complementary & Integrative Medicine

Research Article

The Role of Traditional Chinese Medicine in Immune Dysregulation Associated with Kidney Diseases

Xianlong Zhang[1,2], Mingjie Liang[2], Ziyang Lin[1,2], Minyi Li[2], Tingting Duan[2], Yun Han[2], Lanqing Meng[2], Mengqiu Li[2], Guixuan Lin[2], Tao Xia[2], Ying Lai[2], Boen Liang[2], Bingqiong Li[2], Minhua Li[2], Fengxin Kang[2], Quan Zhu[2], Zhenghai Li[2] and Junzheng Yang[2]*

[1]The Second Affiliated Hospital of Guangzhou University of Chinese Medicine (Guangdong Provincial Hospital of Chinese Medicine), Guangzhou, China

[2]Guangdong nephrotic drug Engineering Technology Research Center, Institute of Consun Co. for Chinese Medicine in Kidney Diseases, Guangdong Consun Pharmaceutical Group, Guangzhou, China

Abstract

The dysregulation of the immune system plays a pivotal role in the pathogenesis and progression of kidney diseases. Abnormal self-antigen recognition can induce inflammatory processes in the kidney, which may ultimately result in kidney damage. Given the paucity of limited therapeutic options for kidney damage mediated by autoantigens and the immune dysregulation inherent in kidney diseases, alternative therapies are imperative and expedient. The accumulative evidence has demonstrated that Traditional Chinese Medicine (TCM) possess significant anti-inflammatory and immunomodulatory properties, suggesting its potential for addressing immune dysregulation associated with kidney diseases. In this review, we summarized the recent applications of TCM in regulating immune dysregulation in kidney diseases, elucidated the underlying mechanisms and identified potential limitations. Hope our review to provide insights for researchers engaged in this field

Keywords: Autoimmune-related kidney diseases; Autoimmune disease-related kidney injury; CKD; Immunomodulation; TCM

***Corresponding author:** Junzheng Yang, Institute of Consun Co. for Chinese Medicine in Kidney Diseases, Guangdong Consun Pharmaceutical Group, Guangzhou 510530, China, E-mail: yangjunzheng606403@163.com

Citation: Zhang X, Liang M, Lin Z, Li M, Duan T, et al. (2024) The Role of Traditional Chinese Medicine in Immune Dysregulation Associated with Kidney Diseases. J Altern Complement Integr Med 10: 529.

Received: October 31, 2024; **Accepted:** November 07, 2024; **Published:** November 14, 2024

Introduction

Chronic kidney disease (CKD) remains a significant public health issue concern on a global scale, with a persistently high incidence that poses a substantial threat to human health. An increasing body of evidence suggests that abnormal regulation of the immune system plays a crucial role in the pathogenesis and progression of kidney disease. In addition to the inflammatory and destructive effects of the kidney inflammation and damage induced by abnormal recognition of autoantigens (such as autoimmune-mediated kidney disease and autoimmune disease-related kidney injury), several articles have demonstrated that chronic kidney pathologies, including diabetic nephropathy, renal fibrosis, ischemia-reperfusion, and drug-related kidney injuries, are also closely associated with immune dysregulation [1,2]. These immune regulation mechanisms involved in kidney disease are often characterized by complex immune responses, including aberrant activation of immune cells, an imbalance in cytokine release, and the deposition of immune complexes. These responses ultimately lead to ongoing kidney damage and a decline in renal function. However, immune cells also possess a dual role. Certain regulatory components of the immune system have the capacity to inhibit renal inflammatory responses, thereby ameliorating kidney damage. This perspective provides novel new insights into the immunological treatment of kidney diseases [3].

TCM has a long history and substantial clinical experience in the treatment of autoimmune diseases. Its multi-component and multi-target characteristics enable it to modulate immune function at various levels, including both the innate and adaptive immune systems, thereby restoring immune balance and alleviating immune-mediated tissue damage. A substantial body of evidence has been conducted on the immunomodulatory effects of acupuncture, acupoint stimulation, and herbal treatments for skin diseases, rheumatic diseases, thyroid disorders, and tumors [4-7]. These investigations demonstrate the broad potential of TCM in regulating immune cell activity, suppressing excessive immune responses, and modulating inflammatory pathways. In the field of immunotherapy for kidney diseases, TCM also demonstrates considerable potential for the therapeutic applications. Numerous clinical trial evidence and basic research evidence have indicated that TCM can effectively improve symptoms and laboratory parameters in patients with immune-related kidney diseases. For example, commonly used herbal remedies such as Astragalus, Epimedium, Morinda officinalis, Cordyceps, Hibiscus abelmoschus, and Tripterygium wilfordii have been demonstrated to exert beneficial effects by regulating immune cells, inhibiting inflammatory responses, and promoting renal repair. Furthermore, TCM treatment modalities such as acupuncture and tui na (therapeutic massage) have exhibited potential protective effects on kidney function by reducing inflammation, improving renal hemodynamics, and regulating mitochondrial energy metabolism, thereby restoring immune balance and mitigating progressive kidney damage [8-10].

As research into the immunomodulatory mechanisms of TCM deepens and modern biotechnologies are integrated, the role of TCM in kidney diseases will become increasingly defined. Further

investigation of the molecular mechanisms underlying TCM's immunomodulatory effects will facilitate to the development of novel treatment strategies for the prevention and management of kidney diseases. This article aims to systematically summarize the immunomodulatory effects of TCM on various immune-related kidney diseases, analyze the underling mechanisms and discuss the limitations, hope to provide a reference for future research and clinical applications.

Relationship between the Immune System and the Kidneys

The immune system is composed of a variety of cells and molecules, including immune cells, secreted antibodies and cytokines, and the complement system. The immune system's activities can be divided into two categories: innate immunity and adaptive immunity. The innate immune system is comprised of monocytes, macrophages, natural killer (NK) cells, and dendritic cells, which collectively serve to protect the body by directly recognizing and eliminating pathogens, releasing cytokines, and initiating inflammatory responses. Adaptive immunity, which is primarily mediated by lymphocytes, involves B lymphocytes producing specific antibodies in response to particular antigens, while T lymphocytes eliminate infected cells or modulate the activities of other immune cells through direct cellular mechanisms [11].

The Activation of adaptive immunity typically necessitates the involvement of the innate immune system. Macrophages, for example, are instrumental in immune surveillance, antigen presentation, and the maintenance of renal homeostasis. The nature and duration of the injury in question will determine the specific response of the macrophages. Macrophages can be observed to exhibit multiple different phenotypes: M1 macrophages are pro-inflammatory and assist in the clearance of infections; however, they can also exacerbate kidney damage through the promotion of inflammation. In contrast, M2 macrophages possess anti-inflammatory properties that facilitate tissue repair. Nevertheless, the excessive regulation of M2 cells can also contribute to the worsening of renal fibrosis. In the context of kidney injury, macrophages have the capacity to directly transform into myofibroblasts, a process known as Macrophage-to-Myofibroblast Transition (MMT). This process is driven by the TGF-β1-Smad3 signaling pathway. MMT may represent a crucial point of transition between the chronic renal inflammation and pathological fibrosis [12].

In addition to their excretory and endocrine functions, the kidneys also play a significant role in the immune system. The effects of renal autoimmunity are often the result of antibody deposition or immune cell infiltration, which target glomeruli, renal tubules, and vascular structures targets of the autoimmune process [13]. Additionally, the kidneys contain resident Innate Lymphoid Cells (ILCs), which are vital components of the immune system and perform crucial functions within the kidneys. In contrast to conventional traditional T lymphocytes, ILCs do not depend on rearranged antigen receptors for activation; instead, they detect local signals through various receptors. Based on their functions, ILCs can be categorized into cytotoxic NK cells and several "helper" ILC subpopulations (such as ILC1, ILC2, and ILC3). ILC1 resembles Th1 cells and expresses T-bet and IFN-γ, while ILC2, defined by GATA-3 expression, produces Th2 cytokines IL-13, IL-5, and IL-4, as well as IL-9 and epidermal growth factor (EGF). ILC3 reflects the function of Th17 cells, which are distinguished by the expression of RORγt and AHR, and produces IL-17 and/or IL-22, GM-CSF, and lymphotoxin [14].

The therapeutic approaches in TCM are distilled into eight distinct methods: "han, tu, xia, he, qing, xiao, wen, and bu." These correspond to practices such as inducing promoting sweating, emetics, catharsis, harmonization, the clearing method (for example, the clearing of heat and detoxification), elimination, warming, and tonification. In accordance with the syndrome differentiation and treatment as espoused by TCM, the application of each method in an appropriate manner has the potential to rectify immune dysregulation. In accordance with the established treatment guidelines, the same herb or its components may exert opposing regulatory effects on the immune system, contingent on the disease state, and thus confer benefit to organism. For example, Astragalus, an herb with known qi-tonifying properties, has been demonstrated to exert immunomodulatory effects across various diseases. A study evaluated the impact of Astragalus on Ana-1 macrophages, demonstrating that it elevated heparinase activity in macrophages, facilitated cellular migration, and augmented mRNA levels and secretion of IL-1β and TNF-α, thereby boosting host defenses against infection [15]. The main component of Astragalus, astragaloside IV (ASI), has been demonstrated to enhance CD45 phosphatase activity, stimulate T and B lymphocyte activity, and induce the expression of various cytokines and chemokines [16]. Conversely, in another study focused on Myasthenia Gravis (MG), an antibody-mediated autoimmune disease, astragaloside IV (ASI) was found to reduce levels of Th1 and Th17 cells while enhancing regulatory T cells (Tregs) and improving gut microbiota, thereby alleviating symptoms of myasthenia [17]. It can therefore be seen that TCM's theoretical framework and pharmacological approaches for achieving coordinated balance in the immune system have significant potential for further basic research and clinical translation.

Inflammation Induced by Immune Dysregulation in the Kidneys and Treatment with TCM

Rapidly Progressive Glomerulonephritis

In the context of autoimmunity, kidney damage primarily manifests as inflammatory kidney diseases. Whether the result of pathogenic immune responses against renal self-antigens or the renal manifestations of systemic autoimmune diseases, the failure to resolve Glomerulonephritis (GNs) can result in the progression to Chronic Kidney Disease (CKD). Nevertheless, some diseases may rapidly advance to end-stage renal disease, a condition known as rapidly progressive glomerulonephritis. One such example is anti-glomerular basement membrane (anti-GBM) disease, where antibody binding activates the complement system, triggering local inflammatory responses. The recruitment of inflammatory cells, including neutrophils and macrophages, to the kidneys, results in the release of cytokines and enzymes that promote glomerular cell injury and structural damage. This can lead to the formation of crescents and the development of Autoimmune Crescentic Glomerulonephritis (ACGN), which can rapidly progress to end-stage renal disease. This condition typically necessitates a combined treatment approach involving plasma exchange and immunosuppressants. Ginsenoside Rg1 has been demonstrated to have a mitigating effect on damage caused by anti-GBM disease. One study demonstrated that ginsenoside Rg1 could reduce IL-1β-induced podocyte inflammation and apoptosis. The effects were significantly reversed by inhibitors of ginsenoside Rg1, which also blocked the inhibitory action of ginsenoside Rg1 on the MAPK pathway [18]. Another study established a mouse model of ACGN with T lymphocyte dysregulation, demonstrating that intervention with armepavine, a major bioactive compound from the folium

nelumbinis, significantly inhibited T cell/macrophage infiltration and NF-κB activation in the kidneys. Additionally, this intervention resulted in a reduction in serum autoantibody levels, and a decrease in the levels of pro-inflammatory cytokines (such as IFN-γ) in both serum and renal tissue. Furthermore, this intervention demonstrated the ability to suppress T/B cell activation and T cell proliferation within the spleen, reduce glomerular immune deposition, and prevent crescent formation. Ultimately, this resulted in an improvement in proteinuria and renal dysfunction. These findings provide a valuable reference for the combined use of TCM in the treatment of rapidly progressive glomerular diseases [19].

Chronic Glomerulonephritis

In the treatment of Chronic Glomerulonephritis (CGN), TCM demonstrates a plethora of therapeutic methods that can also influence immunoregulatory mechanisms. For example, the Xiao Chai Hu Decoction (XD), which exemplifies harmonizing methods, has been demonstrated to restore the balance between Th1 and Th2 cells in CGN patients, reducing the levels of the pro-inflammatory cytokine IFN-γ while increasing the expression of the anti-inflammatory cytokine IL-4. This results in the amelioration of the state of immune dysregulation. Furthermore, XD significantly inhibited the abnormal elevation of IL-17 and RANTES (regulated on activation, normal T cell expressed and secreted), reducing renal inflammation and effectively decreasing proteinuria [20]. In another study, researchers employed the utilisation of Qi Teng Xiao Zhuo granules, an elimination method, in an adriamycin-induced CGN rat model, demonstrating that it improved immune responses by regulating multiple signaling pathways (such as cytokine receptor interactions and B cell receptor signaling), influencing immune cell differentiation and activation, and promoting recovery of renal function [21].

Acteoside (ACT), a principal active component of Rehmannia leaves, is known in TCM for its considerable nourishing effects. The results of research indicate that ACT can improve 24-hour urinary protein and serum creatinine levels in passive Heymann nephritis (PHN) model rats. Furthermore, ACT has been observed to suppress the expression of leukocyte CD18, and dose-dependently reduce the production of TNF-α and IL-6 in macrophages, This suggests that ACT can exert anti-inflammatory effects and modulating immune function [22]. Similarly, Yishen Capsule (YSC), which is also a nourishing agent, has been observed to adjust T lymphocyte subsets by increasing the ratios of CD3, CD4, and CD4/CD8 in clinical applications, enhancing immune tolerance and lowering serum levels of vascular endothelial growth factor (VEGF), which has been demonstrated to help alleviate kidney damage and to mitigate chronic glomerulosclerosis [23,24].

Autoimmune-Mediated Kidney Diseases

In autoimmune-mediated kidney diseases, the imbalance and subgroup changes of lymphocyte function represent pivotal pathological mechanisms. The pathological features of immunoglobulin A nephropathy (IgAN) include the deposition of IgA immune complexes, which lead to the proliferation of mesangial cell and an expansion of matrix. The combined application of artemisinin and hydroxychloroquine has demonstrated that treatment results in a reduction in the proportion of Th2 and Th17 cells, while increasing the proportion of Th1 and regulatory T cells (Tregs). This alteration suggests that TCM can assist in the mitigation of immune-mediated responses by modulating the ratio of CD4+ T cell subgroups, thereby alleviating renal damage in IgAN [25]. An imbalance in T cell subgroups, particularly the Th1/Th2 and Th17/Treg ratios, is closely associated with the occurrence and progression of idiopathic membranous nephropathy (IMN). In some cases of IMN that are unresponsive to hormone or immunosuppressant therapy, the administration of TCM has been observed to result in an increase in CD4+ T cells and IL-2 levels while CD8+ T cells have been observed to decrease. This suggests that TCM can facilitate the remodeling of T cell subgroups, thereby enhancing the function of Tregs to combat autoimmune injury [26]. In membranoproliferative glomerulonephritis (MsPGN), the abnormal proliferation of lymphocytes and inflammatory responses are major pathological features. A compound injection of Hedyotis diffusa (FBI) has been demonstrated to significantly reduce pathological damage in MsPGN rats by inhibiting tubular cell proliferation and macrophage infiltration. This effect is attributed to the main componentof the extract, quercetin, which modulates the NF-κB signaling pathway, thereby regulating lymphocyte activity and reducing immune-mediated inflammatory responses [27]. In models of lupus nephritis, Sairei-to, a Japanese herbal remedy, has been demonstrated to inhibit B cell activation and to improve immune imbalance by enhancing the function of Th2 cells, demonstrating the ability to regulate the Th1/Th2 balance. Restoring this balance is crucial for suppressing excessive immune responses [28]. The classic formula Longdan Xiegan Decoction has been demonstrated to increase the number of CD3+CD4+, CD3+CD8+, and CD4+CD25+ T cells, while significantly reducing the levels of IFN-γ, TNF-α, and anti-dsDNA antibodies. Consequently, it has been established as a valuable adjunctive therapy for patient with Systemic Lupus Erythematosus (SLE) [29]. In the context of focal segmental glomerulosclerosis (FSGS), Jianpi Qinghua Decoctions have demonstrated regulatory effects on the lymphocyte system, characterised by a reduction in reducing the CD4+/CD8+ T cell ratio and the expression of pro-inflammatory factors (such as TNF-α and IL-6), This has led to an improvement in renal damage associated with FSGS [30]. The alterations in lymphocyte subgroups in autoimmune-mediated kidney diseases not only reflect the complexity of the pathological mechanisms of renal immune dysregulation but also offer novel insights into clinical treatment. The T cell activation and differentiation represents an effective strategy for reducing immune inflammatory responses and improving kidney function. This provides a theoretical foundation for the use of TCM in the treatment of autoimmune kidney diseases.

Diabetic Kidney Disease

The pathological mechanisms of Diabetic Kidney Disease (DKD) are complex, and involve a number of different factors, including macrophage polarization, lymphocyte dysregulation, and gut microbiota imbalance. The relative proportions of M1 and M2 macrophages, along with the dysregulation of peripheral T cell immune homeostasis in patients with type 2 diabetes mellitus (T2DM), represent a significant area of research interest with regard to renal inflammation and injury. It has been demonstrated that T2DM patients who also have cardiovascular and renal complications display a markedly diminished degree of specificity and diversity in their T Cell Receptor (TCR) repertoire, reflecting functional defects of T cells in chronic inflammatory responses. This deficiency may result in a weakening of T cell immune responses to pathogens, thereby exacerbating the inflammatory state [31]. The polarization state of macrophages is of particular importance during the progression of DKD. M1 macrophages accumulate in the kidneys due to their pro-inflammatory properties, releasing TNF-α, IL-1β, and IL-6, which further exacerbate local inflammation and tissue damage. The release of these factors stimulates

tubular and glomerular cells, resulting in proteinuria and a decline in renal function. Conversely, M2 macrophages are responsible for tissue repair and anti-inflammatory responses; insufficient M2 function may therefore exacerbate the extent of chronic injury [32]. Furthermore, an imbalance in gut microbiota is regarded as a significant contributing factor in the progression of DKD. A reduction in gut microbial diversity can result in the elevated levels of gut-derived toxins (such as indoxyl sulfate and endogenous lipopolysaccharides), which activate the gut-kidney axis and enhance Toll-like receptor 4 (TLR4) signaling, promoting the formation of M1 macrophages. This process serves to further intensify chronic kidney inflammation. Paeoniflorin (PF), an effective TCM, has been demonstrated to possess anti-inflammatory and immunomodulatory properties. This is achieved by blocking the TLR2/4 signaling pathways, reducing urinary albumin excretion rates, and inhibiting macrophage infiltration and activation, thereby lowering inflammatory responses in DKD [33]. A meta-analysis demonstrated that PF could mitigate kidney mesangial expansion and tubular interstitial damage, reduce 24-hour urinary protein excretion rates, and decrease the expression of inflammatory mediators (MCP-1, TNF-α, iNOS, and IL-1β mRNA) and downstream immune factors (P-IRAK1, TIRF, P-IRF3, MyD88, and NF-κBp-p65). Its renoprotective effects are associated with the suppression of macrophage infiltration and the reduction of inflammatory mediators and immune modulation [34]. A compound preparation known as Tangshen Fang has been found to effectively regulate gut microbiota, restore gut ecological imbalance, and reduce levels of indole sulfate and metabolic endotoxemia/lipopolysaccharide. Its inhibitory effect of the compound on renal inflammation is related to the suppression of indole sulfate receptors and TLR4, which in turn inhibits JNK and NF-κB signaling pathways in the kidneys and improving diabetic kidney damage [35]. The progression of DKD may occur more rapidly as a result of the interplay of multiple factors, including immune dysregulation. The utilisation of TCM to offers the potential for the development of new strategies and targets for the treatment of DKD.

Chronic kidney disease

CKD has traditionally been considered to be the result of the prolonged progression of various kidney diseases. However, there has been a recent increase in interest in relationship between CKD and immune dysregulation has recently garnered increasing attention. In the initial stages of kidney injury, resident cells respond with stress signals that release pro-inflammatory cytokines, attracting immune cell infiltration, particularly the activation of macrophages and T lymphocytes. Furthermore, modifications to the renal microenvironment and the aggregation of uremic toxins can impair lymphocyte functionality, resulting in reduced immune tolerance. T cell subgroups in patients exhibit significant functional disturbances, including an imbalance in Th1/Th2 and a reduction in NK/Terg/IFN-γ has been mentioned above, which amplify autoimmune responses. Additionally, recent studies have also discovered a close correlation between gut microbiota dysbiosis and the immune responses in CKD. The presence of gut bacteria has been demonstrated to result in the production of endotoxins and metabolites that exert a detrimental impact on systemic immune status, thereby exacerbating renal pathological changes.

The available evidence suggests that the activity of NK cells is increased in CKD patients. This is accompanied by a significant upregulation of related cytokines, including perforin and interferon-γ IFN-γ, which points to a crucial role for NK cells in the immune response associated with CKD. Shenkang injection (SKI) has been demonstrated to impede the advancement of renal interstitial fibrosis (RIF) by inhibiting the activation of NK cells, a process that involves the regulation of the STING/TBK1/IRF3 signaling pathway, thereby improving renal function [36]. Huangkui capsules are a commonly used TCM medications for the treatment of kidney diseases, effectively improving renal function and reducing proteinuria in patients with chronic kidney disease, diabetic nephropathy, and IgA nephropathy. The mechanisms of action may include the alleviation of inflammation and oxidative stress, the enhancement of immune responses, the protection of tubular epithelial cells, the improvement of podocyte apoptosis, glomerulosclerosis, and mesangial proliferation, and the inhibition of renal fibrosis [37]. Cordyceps sinensis also has been shown to possess immunosuppressive properties. Its lipopeptide components have been demonstrated to inhibit T and B cell activation and proliferation, reducing the production of IL-2, IL-10, and TNF-α in peripheral blood. This may offer new treatment strategies for hyperimmune diseases [38]. Fufang Shenhua tablets (SHT) and their active component, astragaloside IV (AS-IV), have been demonstrated to exhibit significant anti-inflammatory and immunomodulatory effects by inhibiting NF-κB, TLR, and PI3K/AKT signaling pathways. This further emphasizes the importance of TCM in regulating immune imbalance in CKD [39]. Gut microbiota dysbiosis is also closely associated with immune inflammation in CKD. It appears that dysbiosis, impaired intestinal barriers, and abnormal intestinal immunity may serve as mechanisms underlying immune-related CKD, a connection that has been termed the gut-kidney axis. The use of prebiotics, probiotics, and TCM (such as rhubarb) can facilitate the regulation of gut ecology, reduce oxidative stress, and enhance the communication between local immune systems in the gut and the kidneys [40]. Furthermore, research has demonstrated that Huaier (Trametes robiniophila Murr) has a broad regulatory role in the immune system, exhibiting broad-spectrum activity on various components of both innate and adaptive immune systems, including macrophages, dendritic cells, NK cells, T lymphocytes, and B lymphocytes. Huaier exerts regulatory effects on immune responses, encompassing the expression of damage-associated molecular patterns, the activation and maturation of immune cells, and the influencing cellular proliferation, differentiation, antibody production, cytokine and chemokine expression, and intracellular signaling. These effects have been demonstrated to be beneficial in the context of immune-related kidney diseases [41]. In clinical research, Qingshen granules have been demonstrated to effectively downregulate the CD4+/CD8+ T cell ratio, Th17 cell levels, and NF-κB activity in patients with chronic renal failure (CRF) with damp-heat syndrome. This results in the regulation of immune dysfunction and the reduction of inflammatory mediator's release, which ultimately improved the renal fibrosis [42]. These studies provide a comprehensive analysis of the immunomodulatory effects of various TCM in the context of improving CKD, they suggest that future research should prioritize clinical validation and mechanistic studies in order to facilitate the wider application of these therapeutic strategies.

Summary and Future Research Directions

This article presents a comprehensive review of the critical role of TCM in regulating immune dysregulation associated with kidney diseases, highlighting its multi-target and multi-pathway therapeutic potential. Multiple studies demonstrate that TCM not only improves renal function and attenuates inflammatory responses but also effectively restores immune balance, providing robust empirical support for the use of TCM in in the treatment of kidney diseases.

Nevertheless, despite the existing research laying a foundation for understanding how TCM regulates immune balance, further exploration of its mechanisms, particularly the complex interactions at the cellular and molecular levels, is required. Future research should focus on several pivotal areas, including a comprehensive investigation into the manner by which TCM regulates distinct immune cell subgroups (Th1, Th2, Th17, Treg, and NK cells), with a particular emphasis on their behaviour under conditions of inflammation. Additionally, the role of the gut microbiota in the progression of kidney diseases and its relationship with TCM should be investigated in order to gain a deeper understanding of the physiological and pathological impacts of the gut-kidney axis. Furthermore, the utilization of contemporary biotechnological techniques, including genomics, metabolomics and proteomics, will facilitate a more robust theoretical foundation for the scientific application of TCM in regulating immune balance.

The integration of the holistic perspective of TCM with the precision treatment concepts of modern medicine will facilitate the development of individualised treatment plans targeting specific types of autoimmune-related kidney diseases, thereby enhancing the application of TCM in the prevention and treatment of kidney diseases. It is our intention to fully leverage the unique advantages of TCM in immune modulation for kidney diseases in future research, thereby providing patients with a greater range of effective treatment options that will improve their quality of life and prognosis.

Acknowledgement

None.

Conflict of Interests

There is no conflict of interest in this article.

Funding

Supported by the China Postdoctoral Science Foundation under Grant Number 2024M750631.

References

1. Foresto-Neto O, Menezes-Silva L, Leite JA, Andrade-Silva M, Camara NOS (2024) Immunology of Kidney Disease. Annu Rev Immunol 42: 207-233.
2. Kurts C, Panzer U, Anders HJ, Rees AJ (2013) The immune system and kidney disease: basic concepts and clinical implications. Nat Rev Immunol 13: 738-753.
3. Neumann K, Tiegs G (2021) Immune regulation in renal inflammation. Cell and tissue research 385: 305-322.
4. Wang Y, Chen S, Du K, Liang C, Wang S, et al. (2021) Traditional herbal medicine: Therapeutic potential in rheumatoid arthritis. Journal of ethnopharmacology 279: 114368.
5. Hai YP, Lee ACH, Chen K, Kahaly GJ (2023) Traditional Chinese medicine in thyroid-associated orbitopathy. J Endocrinol Invest 46: 1103-1113.
6. Wang Z, Wang ZZ, Geliebter J, Tiwari R, Li XM (2021) Traditional Chinese medicine for food allergy and eczema. Ann Allergy Asthma Immunol 126: 639-654.
7. Auyeung KK, Han QB, Ko JK (2016) Astragalus membranaceus: A Review of its Protection Against Inflammation and Gastrointestinal Cancers. Am J Chin Med 44: 1-22.
8. Liu X, Wang X, Ma H, Zhang W (2022) Mechanisms underlying acupuncture therapy in chronic kidney disease: A narrative overview of preclinical studies and clinical trials. Front Nephrol 2: 1006506.
9. Zhang J, Yang X, Zhang X, Lu D, Guo R (2021) Electro-Acupuncture Protects Diabetic Nephropathy-Induced Inflammation Through Suppression of NLRP3 Inflammasome in Renal Macrophage Isolation. Endocrine, metabolic & immune disorders drug targets 21: 2075-2083.
10. Zhang ZL, Zhao SH, Li X, Yang YQ, Chen H, et al. (2013) Clinical observation on repair of lymphocyte injury in patients with diabetic nephropathy treated by regulating spleen-stomach needling]. Zhongguo Zhen Jiu 33: 1065-1070.
11. Khaitov RM (200) [Immune system physiology]. Ross Fiziol Zh Im I M Sechenova 86: 252-267.
12. Tang PM, Nikolic-Paterson DJ, Lan HY (2019) Macrophages: versatile players in renal inflammation and fibrosis. Nature reviews Nephrology 15: 144-158.
13. Gorenjak M (2009) Kidneys and Autoimmune Disease. EJIFCC 20: 28-32.
14. Becker M, Gnirck AC, Turner JE (2020) Innate Lymphoid Cells in Renal Inflammation. Frontiers in immunology 11: 72.
15. Qin Q, Niu J, Wang Z, Xu W, Qiao Z, et al. (2012) Astragalus embranaceus extract activates immune response in macrophages via heparanase. Molecules (Basel, Switzerland) 17: 7232-7240.
16. Li CX, Liu Y, Zhang YZ, Li JC, Lai J (2022) Astragalus polysaccharide: a review of its immunomodulatory effect. Arch Pharm Res 45: 367-389.
17. Weng S, Huang L, Cai B, He L, Wen S, et al. (2023) Astragaloside IV ameliorates experimental autoimmune myasthenia gravis by regulating CD4 + T cells and altering gut microbiota. Chinese medicine 18: 97.
18. Guo X, Zhang J, Liu M, Zhao GC (2019) Protective effect of ginsenoside Rg1 on attenuating anti-GBM glomerular nephritis by activating NRF2 signalling. Artificial cells, nanomedicine, and biotechnology 47: 2972-2979.
19. Ka SM, Kuo YC, Ho PJ, Tsai PY, Hsu YJ, et al. (2010) (S)-armepavine from Chinese medicine improves experimental autoimmune crescentic glomerulonephritis. Rheumatology (Oxford, England) 49: 1840-1851.
20. Ding SY, Zheng PD, He LQ, Hou WG, Zou Y, et al. (2013) [The research on xiaochalhu decoction improving the inflammation of chronic glomerulonephritis patients and relieving the proteinuria]. Zhongguo Zhong xi yi jie he za zhi Zhongguo Zhongxiyi jiehe zazhi = Chinese journal of integrated traditional and Western medicine 33: 21-26.
21. Gao JR, Qin XJ, Jiang H, Wang T, Song JM, et al. (2016) The effects of Qi Teng Xiao Zhuo granules, traditional Chinese medicine, on the expression of genes in chronic glomerulonephritis rats. Journal of ethnopharmacology 193: 140-149.
22. Gao W, Zhou Y, Li C, Liu T, Zhao H, et al. (2023) Studies on the metabolism and mechanism of acteoside in treating chronic glomerulonephritis. Journal of ethnopharmacology 302: 115866.
23. Wu XL, Sun WS, Zhang WG, Qiao CL, Ma QY, et al. (2007) Study on effect of yishen capsule in preventing recurrence of chronic glomerulonephritis. Chinese journal of integrative medicine 13: 215-218.
24. Wu XL, Sun WS, Zhang WG, Qiao CL, Wang Z, et al. (2007) [Effect of Yishen capsule on serum vascular endothelial growth factor and cell immunity in patients with chronic glomerulonephritis]. Zhongguo Zhong yao za zhi = Zhongguo zhongyao zazhi = China journal of Chinese materia medica 32: 2416-2418.
25. Bai L, Li H, Li J, Song J, Zhou Y, et al. (2019) Immunosuppressive effect of artemisinin and hydroxychloroquine combination therapy on IgA nephropathy via regulating the differentiation of CD4+ T cell subsets in rats. International immunopharmacology 70: 313-323.

26. Han L, Deng YY, Chen YP (2011) [Clinical observation of Shen No. 9 Recipe with Qingre Moshen Granule on the treatment of idiopathic membranous nephropathy after treated by multiple Western drugs with no efficacy]. Zhongguo Zhong xi yi jie he za zhi Zhongguo Zhongxiyi jiehe zazhi = Chinese journal of integrated traditional and Western medicine 31: 1496-1501.

27. Chang J, Wu L, Tang L, Peng F, He J, et al. (2024) The Effect and Mechanism of Fufang Banbianlian Injection in the Treatment of Mesangial Proliferative Glomerulonephritis. Combinatorial chemistry & high throughput screening.

28. Ito T, Seo N, Yagi H, Ohtani T, Tokura Y, et al. (2002) Unique therapeutic effects of the Japanese-Chinese herbal medicine, Sairei-to, on Th1/Th2 cytokines balance of the autoimmunity of MRL/lpr mice. Journal of dermatological science 28: 198-210.

29. Lee TY, Chang HH (2010) Longdan Xiegan Tang has immunomodulatory effects on CD4+CD25+ T cells and attenuates pathological signs in MRL/lpr mice. International journal of molecular medicine 25: 677-685.

30. Ma XH, He LQ (2014) [Effects of Jianpi Qinghua Decoctions on immune inflammatory injury in adriamycin-induced nephropathic rats MA]. Sichuan da xue xue bao Yi xue ban = Journal of Sichuan University Medical science edition 45: 19-23.

31. Yin Y, Sheng Y, Gao S, Zhang J, Wang W, et al. (2024) Profiling of T cell repertoire in peripheral blood of patients from type 2 diabetes with complication. BMC immunology 25: 10.

32. Li HD, You YK, Shao BY, Wu WF, Wang YF, et al. (2022) Roles and crosstalks of macrophages in diabetic nephropathy. Frontiers in immunology 13: 1015142.

33. Zhang T, Zhu Q, Shao Y, Wang K, Wu Y (2017) Paeoniflorin prevents TLR2/4-mediated inflammation in type 2 diabetic nephropathy. Bioscience trends 11: 308-318.

34. Zhang XE, Pang YB, Bo Q, Hu SY, Xiang JY, et al. (2023) Protective effect of paeoniflorin in diabetic nephropathy: A preclinical systematic review revealing the mechanism of action. PloS one 18: 0282275.

35. Zhao T, Zhang H, Yin X, Zhao H, Ma L, et al. (2020) Tangshen formula modulates gut Microbiota and reduces gut-derived toxins in diabetic nephropathy rats. Biomedicine & pharmacotherapy = Biomedecine & pharmacotherapie 129: 110325.

36. Hao J, Huang X, Guan J, Feng J, Li D, et al. (2022) Shenkang injection protects against renal fibrosis by reducing perforin expression through the STING/TBK1/IRF3 signaling pathways in natural killer cells. Phytomedicine: international journal of phytotherapy and phytopharmacology 104: 154206.

37. Li N, Tang H, Wu L, Ge H, Wang Y, et al. (2021) Chemical constituents, clinical efficacy and molecular mechanisms of the ethanol extract of Abelmoschus manihot flowers in treatment of kidney diseases. Phytotherapy research: PTR 35: 198-206.

38. Wu R, Jia Q, Li X, Ma Y, Zhang J, et al. (2022) Preparation of the sphingolipid fraction from mycelia of Cordyceps sinensis and its immunosuppressive activity. Journal of ethnopharmacology 291: 115126.

39. Li R, Shi C, Wei C, Wang C, Du H, et al. (2023) Fufang shenhua tablet, astragali radix and its active component astragaloside IV: Research progress on anti-inflammatory and immunomodulatory mechanisms in the kidney. Frontiers in pharmacology 14: 1131635.

40. Liu X, Wang X, Zhang P, Fang Y, Liu Y, et al. (2023) Intestinal homeostasis in the gut-lung-kidney axis: a prospective therapeutic target in immune-related chronic kidney diseases. Frontiers in immunology 14: 1266792.

41. Long H, Wu Z (2023) Immunoregulatory effects of Huaier (Trametes robiniophila Murr) and relevant clinical applications. Frontiers in immunology 14: 1147098.

42. Wang YP, Wang D, Jin H, Lv Y, Cheng W, et al. (2016) [Intervention of Qingshen Granule for Immune Inflammation of Chronic Renal Failure Patients with Damp-heat Syndrome]. Zhongguo Zhong xi yi jie he za zhi Zhongguo Zhongxiyi jiehe zazhi = Chinese journal of integrated traditional and Western medicine 36: 1425-1429.

HERALD

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal Of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal Of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal Of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752