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# Review of Chronic Kidney Disease in Older Adults: Pathophysiology, Reciprocal Relationship with Cardiovascular Disease, and Clinical Implications

Shinnattapol Songpholratchanon[1], Pune Phetra[1], Jintapong Zuercher Thammachai[1], Kittanath Limphotong[1], Chananchida Dussadeethommo[1], Yadasiri Rachatasitikul[1]

[1]Panyapiwat Institute of Management Demonstration School, Nonthaburi, Thailand

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***Abstract:*** **The prevalence of chronic kidney disease (CKD) is increasingly high among older adults. This study explores the intricate associations between CKD, aging and cardiovascular disease (CVD). The decline in renal function is due to several age-related changes such as the loss of muscle mass, stiffening blood vessels and impaired immune activity. For elderly individuals, genetic, lifestyle and age-related factors all play a part in having CKD. High blood pressure, diabetes, obesity and smoking are key causes of heart diseases and vascular damage that accelerate kidney injury. This review shows the relationship between CVD and CKD with focus on vascular aging as its main link. This vicious cycle worsens both diseases. It also highlights challenges in diagnosing and managing CKD among older persons which will require more research for improved prevention measures and management strategies. To improve the health outcomes of patients suffering from this disease, especially for old, aged people requires deep understanding of these aspects and eventually their quality of life should be enhanced.**

***Keywords:*** **chronic kidney disease,** vascular system, **cardiovascular disease, aging, elderly.**

## I. INTRODUCTION

The world's elderly population is growing at an unprecedented rate, especially in developed countries. Estimates predict an increase in life expectancy to 88 years for men and 91 years for women by 2030 [1]. This rapidly growing elderly population highlights the need to better understand the mechanisms of aging, particularly the aging process of individual organs. Renal aging is of particular importance, as it involves complex molecular, cellular, structural, and functional changes that can lead to increased susceptibility to environmental and internal stresses [2].

Age-associated modifications of the kidneys include changes in glomerular structure, such as thickening or wrinkling of the glomerular basement membrane, and expansion of the mesangial matrix [3,4]. These structural changes are accompanied by a progressive decline in renal function, including reduced glomerular filtration rate, tubular dysfunction, decreased sodium reabsorption, and impaired urine concentrating capacity [5]. Consequently, the aged kidneys' ability to withstand environmental insults and injury is compromised, leading to a higher susceptibility of the elderly population to acute kidney injury and chronic kidney disease [6,7].

To better understand the mechanisms of renal aging and develop effective therapeutic interventions, a comprehensive profile of the molecular changes during aging is crucial. Over the past two decades, mass spectrometry-based proteomics has emerged as a powerful tool to identify differentially expressed proteins between young and aged populations. While earlier studies using two-dimensional electrophoresis (2-DE) were limited in their coverage of the proteome, recent advancements in gel-free analysis and stable isotope-coded labeling have enabled the accurate identification and quantitation of thousands of proteins. These studies have provided valuable insights into the protein changes associated with renal aging, but the variations between different datasets need to be further validated.

The objective of this review is to investigate the pathophysiology of chronic kidney disease (CKD) in the elderly population, emphasizing the mutually reinforcing link between CKD and cardiovascular disease (CVD). The review aims to identify important genetic, lifestyle, and age-related factors impacting CKD progression and clarify how vascular aging contributes to reduced renal function. It also aims to highlight the significance of lowering cardiovascular risk to prevent kidney disease and to investigate practical CKD management techniques for the elderly. It underscores the need for additional research and specific measures to enhance health outcomes for this affected group.

**Physiological Changes in Aging**

Physiological changes in aging are multifaceted and affect various systems in the body such as sarcopenia, and a muscle change in aging, involving a decline in lean muscle mass, which can significantly impact activity levels and quality of life [8]. This is accompanied by microscopic and macroscopic changes in muscle in age, influenced by factors such as nutrition and changes in hormone levels.

Structural and functional changes in fascial tissue, skeletal muscle, and nerves during aging can lead to a decline in a person's overall physical performance [9]. This can be seen through increased stiffness and reduced elasticity of fascia, loss of skeletal muscle mass and strength, regenerative potential, and a weakened interaction between muscular and fascial structures. The nervous system will also change, including motor atrophy, reduced motor cortical excitability, and plasticity, which can lead to the accumulation of denervated muscle fibers [9]. The study from 2022 highlights the role of androgens in various physiological processes, including muscle mass and bone density, and how their levels can change with age [10].

The physiology and pathology of T-cell aging show apparent modifications with organismal aging over time, including T-cell dysfunction, which could be the cause of various chronic age-associated diseases in older adults as well as lowered resistance to infection [11].

Vascular Stiffness in Aging and Disease reviews the understanding of increased vascular stiffness with aging, and how it contributes to the adverse effects of major human diseases [12]. Additionally, oxidative stress, a hallmark of aging, is implicated in various age-related conditions, including cardiovascular diseases like chronic obstructive pulmonary disease, chronic kidney disease, neurodegenerative diseases, and cancer. Oxidative stress plays a crucial role in the pathogenesis of these diseases, highlighting the importance of understanding and addressing the impact of oxidative stress on cardiovascular health in aging individuals [13].

These changes in physiology with aging can have significant implications for overall health and quality of life, and understanding these changes is crucial for developing effective interventions to mitigate the effects of aging.

Focus on the physiological changes of the kidney, the aging course impacts the kidneys permanently, leading to different physiological changes. The kidneys undergo a decrease in tissue volume and a failure in function. Mainly apply to decrease in the number of nephrons in the filtering units. This decline of the nephrons affects the kidneys' ability to filter waste from the blood.

Physiological changes in the aging of kidneys involve a gradual decrease in renal blood flow and the glomerular filtration rate (GFR) with about a 10% decrease per decade after the age of 40 years old. Structural alterations like hyalinization of arterioles to increased sclerotic glomeruli and tubulointerstitial fibrosis contribute to the decline in renal function with age [14].

Moreover, aging of the kidneys become less able to regulate electrolytes, acid-base balance, and fluid homeostasis which will make older adults more affected by conditions like intense kidney injury and chronic kidney disease also Gender differences play a role with estrogens potentially offering a protective effect on the aging kidney compared to males [15].

These physiological changes in the kidney's aging have increased older individuals' vulnerability to renal complications and emphasize the importance of understanding and addressing age-related kidney function decline.

**Physiological and Pathological causes of CKD**

Understanding how the body normally functions and being able to identify deviations from the normal state is necessary for differentiating between physiology and pathology. The problem of pathological structures and behaviors is quite enormous. It refers to the whole of anatomical, embryological, physiological, and psychological research. It deals with studies of diseases and abnormal conditions [16,17]. The definition of physiology would not be exact for these two reasons: firstly, it is susceptible to objective measurement; secondly, the pathology must be understood as a type of normal or in other words, what constitutes another normal. Normal is defined as that which conforms to the rule or is the regular. Physiology is a science in terms of its methods, less so in specifying what in terms of its object. Physiology would lean towards the history and processes of living organisms. To identify physiology, everything depends on one's concept of health [16,17]. Physiology is the study of nothing other than the functions of living beings [16,17].

Chronic kidney disease is the presence of kidney damage or a state of progressive loss of kidney function, resulting in the need for renal replacement therapy. The physiological causes can come from many things. Some of the most common physiological causes of CKD are Diabetes mellitus type 2 (30% to 50%), Diabetes mellitus type 1 (3.9%), and Hypertension (27.2%) [18]. The pathology has been described as chronic tubulointerstitial nephritis, with no specific lesions identified [19]. Some examples are glomerular diseases that affect the glomeruli, infections that can spread to the kidneys, obstructive nephropathy or obstructions in the urinary tract, autoimmune disorders, medications, and vascular disorders [20].

**The Study of CKD in Elderly Patients**

CKD is a significant public health concern, particularly among the elderly population. The prevalence of CKD is expected to increase with the aging population, leading to a significant burden on healthcare systems worldwide. The diagnosis and management of CKD in the elderly are critical, as the disease can have a profound impact on quality of life, morbidity, and mortality.

The prevalence of fatigue and risk of falls among elderly patients with CKD is a significant concern. A study found that almost half of elderly patients with CKD had a risk of fall (45%), which was more prevalent in the hemodialysis group (54%). Fatigue was also a common symptom, with (68%) of participants being fatigue-positive, which was more prevalent in the hemodialysis group (82%) [21].

The pattern and progression of CKD in a group of patients in Sulaimani City were studied. The results showed that the leading causes of CKD in children were glomerular diseases and congenital urological malformations. In contrast, in adults and the elderly group, diabetic nephropathy, glomerular diseases, and hypertension were the most common causes [22]. The study also found that about 50% of all patients were diagnosed when they reached advanced stages (stage IV, V), and about 90% of patients diagnosed at early stages progressed to advanced stages.

The effects of HbA1c on the development and progression of CKD in elderly and middle-aged Japanese individuals were investigated. The study found that the risks of the development and progression of CKD increased from HbA1c levels > 7% (1.43 for 7-9% and 1.67 for >9% compared with the reference of <7%) [23].

The approach to the renal condition of the elderly requires diagnostic tools for this age group, which allow for discerning its renal condition between chronicity and senescence. The HUGE scale was found to be a companion tool to determine the existence of chronic kidney disease in older adult patients seen in outpatient clinics [24].

The management of CKD through Ayurveda was studied, and the results showed that the changes in blood parameters and RFT were noted and systematically analyzed after each treatment [25]. It was found that there was an increase in Hb level, and reduction of values of serum creatinine, blood urea, and urinary excretion of albumin [25]. A marked symptomatic improvement was found in the patient [25].

The effects of a metabolic mixture on gut inflammation and permeability in elderly patients with CKD were investigated. The study found that the supplementation of this mixture was associated with improved intestinal barrier dysfunction [26]. Resistant hypertension in elderly people with CKD was studied, and the results showed that the frequency of resistant hypertension was high in elderly patients with CKD [27].

The practical application of 'STOPP/START' criteria in elderly patients with atrial fibrillation and CKD was analyzed. The study found that the frequency of resistant hypertension was high in elderly patients with CKD [28].

The effects of dietary intervention on nutritional status in elderly individuals with CKD were evaluated. The study found that the low-protein adequate energy intake (LPAE) diet was prescribed, and the results obtained showed no increased malnutrition risk incidence but, rather, an improvement in body composition and metabolic parameters [29].

The ethical principles in elderly and frail patients with advanced CKD were reviewed. The study found that the basis for all processes involved is the ethical principles that are the key support to guide the care providers through the treatment options [30].

The relationship between chronic kidney disease and cognitive disorders in the elderly was described. The study found that current treatment options for CKD with cognitive impairment aimed at common risk factors, including angiotensin-converting enzyme inhibitors (ACEI), angiotensin receptor blockers (ARBs), SGLT-2 inhibitors., GLP-1 RA, and DPP-4 inhibitors [31].

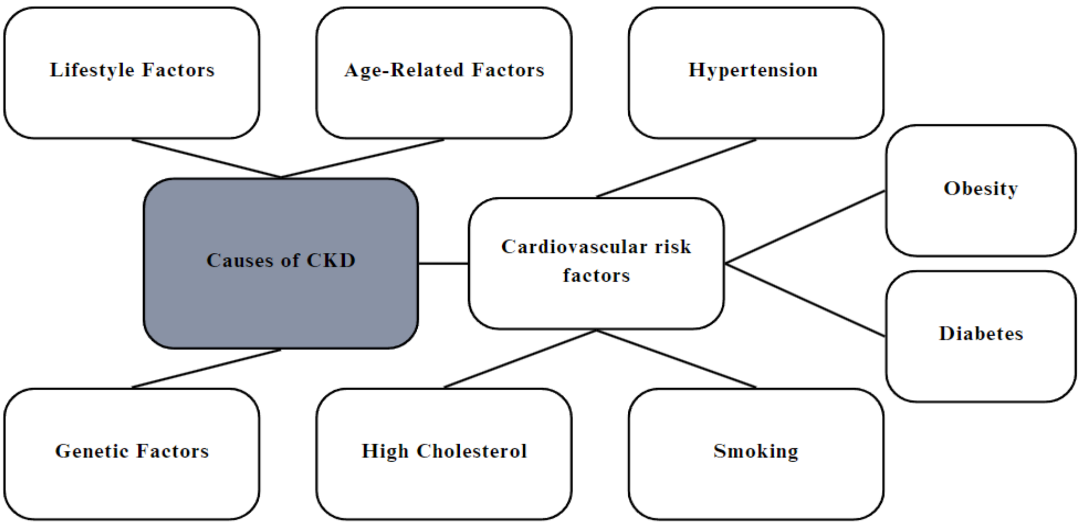
The effects of the modified antitubercular treatment regimen on renal function in patients with CKD and pulmonary tuberculosis were studied. The study found that the change in serum creatinine levels at six months from baseline in two study groups that included patients aged ≤50 and >50 years [32]. The median changes in serum creatinine and eGFR values from baseline were -0.19 and -0.23 mg/dl and 4.16 and 3.93 ml/min/m2 for the two study groups, respectively [32]. Furthermore, the differences in BMI from baseline were 1.91 and 2.14 kg/m2, respectively, for the two groups. The renal function was found to be improved after six months of treatment with modified antitubercular drugs [32]. The intergroup comparisons were not statistically significant [32].

The aging kidney is a complex issue, and the diagnosis and management of CKD in the elderly requires a comprehensive approach that considers the unique challenges and needs of this population. Further research is needed to determine the most effective strategies for preventing and managing CKD in the elderly, including the optimal dietary protein intake, the role of heat stress in CKD, and the impact of CKD on cognitive function and resilience.

## II. FACTORS AFFECTING CKD

According to a study that was published in the Journal of the American Society of Nephrology, older persons with a family history of kidney illness are more likely to develop CKD [33]. In addition, the German Chronic Kidney Disease (GCKD) cohort study found that 20% of patients with moderate CKD suffered from an unknown primary cause of their illness and that patients had a significant degree of confusion regarding the causes of their condition [33]. There is a wide range of varied causes and risk factors and the aspects that will be focused on are included in Fig. 1.

**FIG 1. CAUSES AND RISK FACTORS OF CHRONIC KIDNEY DISEASE**




### Genetic Factors

Genetic factors play a crucial role in the development of CKD, especially in the elderly. Research has shown that inherited kidney diseases (IKDs) are among the leading causes of early-onset CKD and are responsible for at least 10-15% of cases of kidney replacement therapy (KRT) in adults [34]. IKDs can be difficult to diagnose in adulthood due to various reasons, including the lack of knowledge among adult nephrologists, atypical phenotypes, and the availability of genetic testing [34].

**Lifestyle Factors**

Lifestyle factors, such as hypertension, diabetes, and obesity, are significant contributors to the development of CKD. A study in Nigeria found that the prevalence of CKD was highly related to age, gender, hypertension, obesity, history of diabetes mellitus, use of herbal medicines, and prolonged use of nonsteroidal anti-inflammatory drugs [35]. Similarly, a study in Indonesia found that age, smoking behavior, history of diabetes mellitus, and hypertension were associated with the stage of chronic kidney insufficiency [36].

**Age-Related Factors**

Age is a significant risk factor for CKD, and the risk increases with age. The aging kidney is at increased risk for acute and chronic kidney injury due to altered kidney physiology [37]. Additionally, age-related changes in the kidney, such as decreased renal function and increased oxidative stress, can contribute to the development of CKD [38].

Cardiovascular risk factors also play a significant role in the development and progression of chronic diseases in older individuals, and understanding the impact of these risk factors becomes crucial in managing and preventing chronic conditions. Several key risk factors, including hypertension, diabetes, obesity, smoking, and high cholesterol, have been identified as major contributors to cardiovascular disease and associated complications in the elderly population. The causes of CKD in the elderly have a significant impact on the development and progression of the disease. For example, hypertension and diabetes are common comorbidities that can accelerate the progression of CKD [37]. Similarly, obesity and smoking can increase the risk of CKD [35,36].

**Hypertension**

Hypertension, a common cardiovascular risk factor, is closely linked to kidney dysfunction and decline. Studies have shown that hypertension can accelerate vascular damage, compromise kidney function, and lead to CKD in older adults [39-41]. The activation of the renin-angiotensin-aldosterone axis is implicated in the pathophysiology of kidney function decline associated with hypertension, highlighting the importance of managing blood pressure to prevent further deterioration of kidney health [39].

**Diabetes**

Diabetes, particularly in the context of aging, poses a significant risk for chronic kidney disease and cognitive impairment. The association between diabetes and kidney dysfunction is well-established, with diabetic kidney disease being a common complication in older individuals. Normoalbuminuric chronic kidney disease (NA-CKD) is increasingly prevalent among diabetic patients, emphasizing the need for improved glucose control and early detection to mitigate the risk of cardiovascular complications and cognitive decline [42].

**Obesity**

Obesity is another critical cardiovascular risk factor that can impact kidney hemodynamics and accelerate the progression of kidney dysfunction in older adults. Studies have shown that obesity, along with other risk factors like hypertension and diabetes, can further exacerbate the deterioration of kidney function and increase the risk of chronic kidney disease [39,40]. Managing weight and adopting a healthy lifestyle are essential in reducing the burden of obesity-related complications in the elderly population.

**Smoking**

Cigarette smoking has been linked to chronic kidney disease and rapid renal function decline in older adults, particularly among African Americans. Current smokers have shown a higher incidence of renal function decline compared to non-smokers, highlighting the detrimental effects of smoking on kidney health [43]. Smoking cessation is crucial in reducing the risk of cardiovascular disease, chronic kidney disease, and other smoking-related complications in older individuals.

**High Cholesterol**

High cholesterol levels are associated with an increased risk of cardiovascular disease and cognitive decline in older adults. Dyslipidemia, along with other traditional risk factors, can impact kidney hemodynamics and contribute to the progression of kidney dysfunction [39]. Managing cholesterol levels through lipid-lowering drugs and lifestyle modifications is essential in preventing cardiovascular complications and preserving kidney function in the elderly population.

The causes of CKD in the elderly significantly impact the disease's development and progression, such as hypertension and diabetes are common comorbidities that can accelerate the progression of CKD [37]. Similarly, obesity and smoking can increase the risk of CKD [35,36]. Genetic factors, such as IKDs, can also have a significant impact on the development of CKD [34]. Understanding these causes is crucial for the development of effective prevention and treatment strategies for CKD in this age group. Further research is needed to identify the specific causes of CKD in the elderly and to develop targeted interventions to reduce the burden of this disease.

## III. HETEROGENEITY IN AGING AND CKD

Heterogeneity in aging and CKD refers to the diverse and complex interplay of factors that influence the progression of kidney disease in older adults. This phenomenon is characterized by significant variability in the rate and extent of kidney function decline, as well as the presence and severity of comorbidities, across different age groups and populations. Genetics can also be a factor that predisposes individuals to CKD.

Several factors, such as genetic predisposition, individual health trajectories, and environmental exposures, can be blamed for the variation in aging and CKD. For example, genetic differences in the kidneys' ability to filter waste products could influence an older adult's chance of getting CKD. This was found in a study published in the Journal of the American Society of Nephrology [44]. Furthermore, the Systolic Blood Pressure Intervention Trial (SPRINT) showed that intensive blood pressure control helps reduce cardiovascular and mortality outcomes in younger patients without CKD or cardiovascular disease, but not in younger patients with pre-existing conditions. Intensive blood pressure control did, however, benefit older individuals who already had CKD or CVD, but not those who did not [45].

**Prevention and Management**

It requires an extensive approach to prevent and treat CKD in older persons, which is the intricate interactions among various factors that result in heterogeneity. This involves lifestyle changes such as a balanced diet, regular exercise, and early detection and treatment of diabetes, hypertension, and other cardiovascular risk factors. It has been found that pharmacological treatments, such as the use of sodium-glucose cotransporter 2 (SGLT2) inhibitors, lower the risk of cardiovascular events and progressive kidney disease in people with and without type 2 diabetes [46].

**Impact on Treatment**

Treatment approaches are greatly affected by the variety of aging and CKD. An example of that is the SGLT2 inhibitor effects on kidney function and cardiovascular outcomes differ by age and sex, with older adults and women benefiting more from these drugs, according to a study published in the Journal of the American Society of Nephrology [46]. Similarly, a study published in the Journal of the American Heart Association found that adding more clinical and laboratory variables could improve the predictive use of myocardial perfusion imaging (MPI) in patients with chronic kidney disease [47].

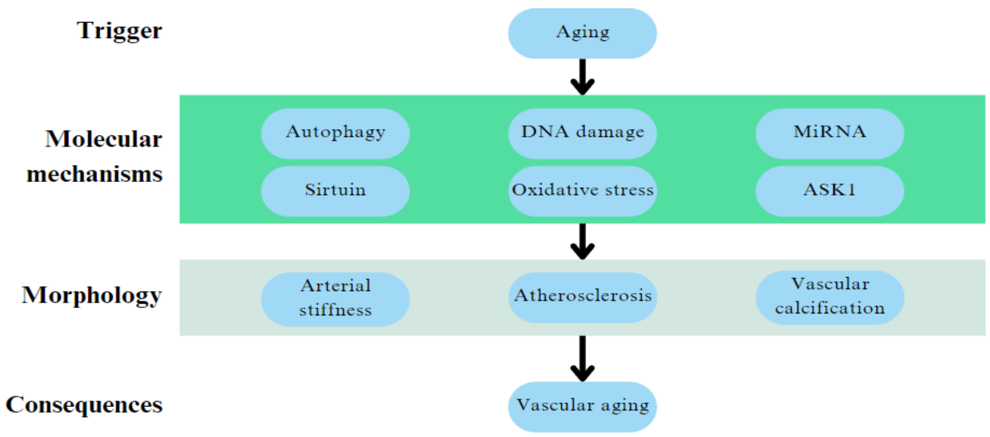
The heterogeneity in CKD and aging is an extremely complex problem that demands a precise, unique approach to management and prevention. Healthcare practitioners can develop more effective methods to lessen the burden of CKD in older persons by understanding the various elements that lead to this heterogeneity.

## IV. THE VASCULAR CULPRIT: BRIDGING THE GAP BETWEEN CKD AND CVD

The vascular system undergoes significant changes as we age, which can lead to the development of CKD and CVD. Arteries stiffen and lose elasticity, potentially leading to hypertension and reduced blood flow to the kidneys, making them more vulnerable to damage [48]. This vascular aging is an essential element of renal deterioration brought on by age, and it is exacerbated by established cardiovascular risk factors like hypertension, diabetes, and smoking, which can compromise both the heart and kidneys [49]. The aging process is linked to structural modifications in the kidneys, including tubular atrophy, glomerulosclerosis, thickening of the glomerular basement membrane, arteriosclerosis, and loss of renal mass [50,51].

The relationship between vascular aging and hypertension is complex and multifaceted. Vascular aging refers to the structural and functional changes of the arterial wall with age, and it plays a crucial role in elderly diseases, such as hypertension. The mechanism of vascular aging and its influence on hypertension have been extensively studied, and it has been shown that vascular aging can lead to increased blood pressure, which in turn can exacerbate CKD and CVD [52]. Furthermore, the decline in autophagy levels, DNA damage, microRNA, oxidative stress, sirtuin, and apoptosis signal-regulated kinase 1 (ASK1) are all integral to vascular aging, and they can contribute to the development of CKD and CVD [53].

**FIG 2. THE MECHANISM OF VASCULAR AGING** [53]




The role of SGLT2 inhibitors in vascular aging is also an area of interest. These inhibitors have been shown to improve vascular function and delay vascular aging, which can, in turn, reduce the risk of CKD and CVD [53]. Additionally, the assessment of arterial stiffness, a common feature of aging, has become an attractive tool for identifying structural and functional changes in the arteries even in the early stage of atherosclerotic disease. Arterial stiffness has been recognized as an important physio-pathological determinant for the age-related rise in systolic blood pressure, demonstrating also an independent predictive value for cardiovascular events [54].

According to Yi et al [2], the comparative proteomics analysis identified 108 proteins that were differentially expressed in young and aged mouse kidneys, with 27 proteins identified as potential renal aging biomarkers. Notable biomarkers included phosphoenolpyruvate carboxykinase (Pck1), CD5 antigen-like protein (Cd5l), aldehyde dehydrogenase 1 (Aldh1a1), and uromodulin. The study highlighted the downregulation of peroxisomal proteins and upregulation of IgGs in aged mice, suggesting peroxisome deterioration as a hallmark of renal aging. Glutathionylome analysis revealed that the downregulation of catalase and glutaredoxin-1 (Glrx1) increased protein glutathionylation in aged mice. Furthermore, the administration of nicotinamide mononucleotide (NMN) enhanced peroxisome biogenesis in aged mouse kidneys, potentially reducing kidney injuries.

The vascular culprit plays a central role in developing CKD and CVD. The changes that occur in the vascular system with age, including the stiffening of arteries and the loss of elasticity, can lead to hypertension and reduced blood flow to the kidneys, making them more susceptible to damage. The relationship between vascular aging and hypertension is complex and multifaceted, and it is influenced by a variety of factors, including the decline in autophagy levels, DNA damage, microRNA, oxidative stress, sirtuin, and apoptosis signal-regulated kinase 1 (ASK1). The role of SGLT2 inhibitors in vascular aging is also an area of interest, and they have been shown to improve vascular function and delay vascular aging, which can in turn reduce the risk of CKD and CVD.

**A Vicious Cycle: The Mutual Induction of CKD and CVD**

CKD and CVD share a complex and bidirectional relationship, forming a vicious cycle that accelerates the progression of both conditions. Age-related vascular changes play a pivotal role in this interplay, contributing to the damage of the kidneys and exacerbating cardiovascular health issues [55]. Vascular aging, characterized by arterial stiffness and reduced elasticity, can lead to hypertension and compromised blood flow to the kidneys, initiating the cascade of events that worsen both CKD and CVD [56].

CKD significantly impacts cardiovascular health by contributing to high blood pressure, inflammation, and abnormal blood sugar levels [57]. The presence of CKD can exacerbate cardiovascular risk factors, leading to a higher incidence of hypertension, atherosclerosis, and endothelial dysfunction [58-60]. This bidirectional relationship between CKD and CVD highlights the intricate connections between kidney function and cardiovascular health, emphasizing the need for comprehensive management strategies that target both conditions simultaneously.

Understanding the complex mechanisms underlying the relationship between CKD and CVD is crucial for developing effective preventive and therapeutic interventions. Studies have explored various factors, such as vitamin D deficiency, vascular calcification, and the economic impact of early CKD diagnosis, shedding light on the multifaceted nature of this relationship [61,62]. Additionally, research has delved into the impact of cognitive impairment patterns in CKD patients [63], the role of vegetarian diets in CKD progression [64], and the association between hemoglobin variability, oxidative stress, and inflammation in CKD patients [65,66]. By addressing these key factors and understanding the intricate connections between CKD and CVD, healthcare providers can develop more targeted and effective strategies to manage and mitigate the burden of these interconnected diseases.

The relationship between CKD and CVD is a complex interplay that involves age-related vascular changes, shared risk factors, and intricate pathophysiological mechanisms [67,68]. By recognizing the bidirectional nature of this relationship and addressing the underlying factors that contribute to the progression of both conditions, healthcare professionals can implement holistic approaches to improve outcomes for patients with CKD and CVD [69]. Further research and clinical interventions focused on understanding and targeting the connections between these diseases are essential for advancing patient care and reducing the burden of CKD and CVD on individuals and healthcare systems [70,71].

## V. CLINICAL IMPLICATIONS AND FUTURE DIRECTIONS

CKD in elderly people poses a significant challenge in the healthcare and medical fields due to its complex interplay of both physiology and pathology [72,73]. Studies have also shown that one of the primary risk factors for CKD is aging, and as the population ages, the prevalence of CKD among the elderly continues to rise unstoppably, leading to clinical implications and nephrology care challenges. Therefore, understanding the complexity of CKD in the elderly is indeed necessary for improving patient treatment and advancing care practices.

CKD in older adults often presents with subtle or atypical symptoms, leading to underdiagnosis and delayed treatment [74,75]. The progression of CKD in the elderly is associated with an increased risk of cardiovascular disease, frailty, and death. Moreover, comorbidities such as diabetes and hypertension further complicate the management of CKD in this population [76].

Treatment strategies for CKD in older adults should focus on slowing the development of the disease, managing symptoms, and addressing comorbidities to improve overall health outcomes. Lifestyle modifications, including dietary adjustments and regular physical activity, also play an important role in managing CKD in the elderly population [77]. Ultimately, to effectively manage older patients, it is important to understand the impact of CKD on older individuals, which can enable primary care physicians and nephrologists to adopt a comprehensive approach to care, considering patients' individual goals and values [78].

Looking towards the future, advancements in nephrology care for elderly patients with CKD hold promise for improving patient outcomes and enhancing quality of life. Emerging therapies targeting specific pathways involved in CKD pathogenesis, such as renin-angiotensin-aldosterone system blockade and novel anti-fibrotic therapies, may offer new treatment options for elderly individuals with CKD [79-81].

Furthermore, innovative approaches to patient care, such as telemedicine and remote monitoring, hold the potential to enhance accessibility to healthcare services, offering a safer environment for patients and improving disease management for older adults with CKD [82]. However, studies have shown that, despite all the benefits, there are still concerns about the quality of care due to limitations in physical examinations and potential mistrust among patients. Despite all the challenges, understanding patient, care partner, and clinician perceptions of telehealth is crucial for successful implementation and expansion efforts to ensure patient-centered care for older adults with CKD in the future [83].

## VI. CONCLUSION

The fact that the number of elderly patients with CKD is increasing underscores the need to recognize better how aging and heart health are related to kidney function. CKD in elderly adults is multifactorial, resulting from complex changes in body functions as we age, genetic factors, and lifestyle choices. This link between CKD and heart problems is led by blood vessels changes and underscores the importance of identifying both conditions early for preventive interventions. However, newer research and medical treatments provide reasons for hope amidst challenges in diagnosing or treating CKD among older persons. There is a need to understand how this disease attacks different individuals so as to design targeted remedies which will enhance the life of aging people suffering from CKD. Better care services can be provided in hospitals by focusing on what causes and results from CKD in old people.

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