

Impact of Cardiovascular-Kidney-Metabolic Syndrome on Quality of Life: Current Perspectives and Future Directions

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ABSTRACT

Cardiovascular-Kidney-Metabolic Syndrome (CKMS) is a multifaceted condition involving cardiovascular disease, chronic kidney disease, and metabolic disorders such as diabetes, hypertension, and obesity, significantly impacting the Quality of Life (QoL) of those affected. This review delves into the comprehensive effects of CKMS on QoL, emphasizing the physical, psychological, and social challenges faced by patients. Physically, CKMS manifests through symptoms like fatigue, dyspnea, pain, and reduced physical activity, impairing functional capacity and daily living. Psychologically, individuals with CKMS often experience depression, anxiety, and cognitive impairments, which further diminish QoL. Socially, CKMS leads to isolation, increased caregiver stress, and substantial economic burdens due to the complexities of managing multiple chronic conditions. Current strategies to enhance QoL in CKMS involve a multidisciplinary approach, including patient education, psychosocial support, and lifestyle modifications. Pharmacological treatments are essential for managing the underlying conditions, yet continuous research is necessary to refine these therapies and optimize patient outcomes. Future directions for improving QoL in CKMS focus on precision medicine, leveraging technology-driven interventions, and integrated care models that address both medical and psychosocial needs comprehensively. Ultimately, a holistic, patient-centered approach is critical to mitigating the adverse effects of CKMS on QoL and enhancing the overall well-being of affected individuals. Addressing CKMS requires a collaborative effort among healthcare providers, patients, and policymakers to develop and implement effective strategies that improve the lives of those living with this challenging condition.

Keywords: Cardiovascular, Impact on patient care, Interplay, Kidney, Metabolic Syndrome, Multidisciplinary Care, Quality of life, Well-being,

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INTRODUCTION

Cardiovascular disease (CVD), Chronic Kidney Disease (CKD), and metabolic disorders such as obesity, diabetes, and hypertension are global health burdens that affect millions of individuals. When these conditions occur concurrently, they form a complex and multifaceted clinical entity referred to as Cardiovascular-Kidney-Metabolic Syndrome (CKMS) (Johnson *et al.*, 2014). This syndrome involves the overlapping pathophysiological mechanisms of CVD, CKD, and metabolic disorders, each of which individually contributes to the impairment of physical, emotional, and social well-being (Cummings *et al.*, 2012).

In recent years, the focus of research has expanded beyond the mere prevention and management of these conditions to the understanding of their collective impact on patients' overall Quality of Life (QoL). Quality of life, particularly in patients suffering from CKMS, is a critical but often overlooked aspect of healthcare. This review explores the profound impact of CKMS on QoL, the factors that contribute to its deterioration, and the implications for clinical practice (Akbari *et al.*, 2023, Stefen *et al.*, 2023). Additionally, we will discuss the current approaches for managing QoL in individuals with CKMS and provide insight into future directions for improving the overall health and well-being of this patient population.

Epidemiology

Cardiovascular-Kidney-Metabolic Syndrome (CKMS) is a growing concern globally, with its prevalence increasing due to rising rates of obesity, diabetes, and hypertension (Zhang *et al.*, 2024). CKMS involves the interplay of Cardiovascular Disease



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(CVD), Chronic Kidney Disease (CKD), and metabolic disorders, leading to significant health burdens (Johnson *et al.*, 2023).

Prevalence

Recent studies have shown a high and increasing prevalence of CKMS among adults. For instance, an analysis of the National Health and Nutrition Examination Survey (NHANES) data from 1999 to 2020 revealed that over half of US adults (56.5%) exhibited CKMS features, with 18.3% classified as stage 01 and 7.9% as stage 02. The prevalence of CKMS stages has been rising over the past two decades, emphasizing the need for comprehensive preventive strategies (Tian *et al.*, 2024).

Demographic Factors

CKMS prevalence varies across different demographic groups. Age, sex, and race/ethnicity play significant roles in determining the likelihood of developing CKMS. Older adults and certain ethnic groups, such as African Americans and Hispanics, are at higher risk due to genetic predisposition and lifestyle factors (Rodriguez *et al.*, 2023). Additionally, socioeconomic status influences CKMS prevalence, with lower-income individuals facing higher risks due to limited access to healthcare and healthy lifestyle options.

Social Determinants of Health

Social determinants of health, including income, education, and access to healthcare, significantly impact CKMS prevalence. Individuals with lower income levels and limited access to healthcare are more likely to develop CKMS due to challenges in managing chronic conditions and adopting healthy behaviors (Rubenstein *et al.*, 2022, Smith *et al.*, 2022). Addressing these social determinants is crucial for reducing CKMS prevalence and improving overall health outcomes.

Pathophysiological Basis of Cardiovascular-Kidney-Metabolic Syndrome

Before delving into the impact of CKMS on QoL, it is essential to understand the interrelationship between the cardiovascular, kidney, and metabolic systems. The pathophysiology of CKMS is driven by a complex interplay of genetic, environmental, and lifestyle factors that promote inflammation, oxidative stress, endothelial dysfunction, and metabolic dysregulation (Sharma *et al.*, 2023); (Huang *et al.*, 2024); (Dey *et al.*, 2024). These factors synergistically accelerate the progression of each disease and worsen their individual and combined impacts on the body.

Cardiovascular Disease (CVD)

The heart and blood vessels are integral to the functioning of every organ system. In CKMS, cardiovascular disease manifests through conditions such as atherosclerosis, myocardial infarction, stroke, heart failure, and arrhythmias. The presence of hypertension,

diabetes, and dyslipidemia further exacerbates cardiovascular risk and contributes to the decline in heart function.

Chronic Kidney Disease (CKD)

Kidney dysfunction in CKMS is a consequence of the combined burden of hypertension, diabetes, and atherosclerosis. As kidney function declines, the ability to filter waste products diminishes, leading to the accumulation of toxic substances in the blood, fluid imbalance, and electrolyte disturbances. This can precipitate the progression of cardiovascular disease, creating a vicious cycle of declining function in both organs.

Metabolic Disorders

Metabolic syndrome is characterized by the co-occurrence of insulin resistance, abdominal obesity, hypertension, and dyslipidemia. It is a major risk factor for the development of type 2 diabetes, cardiovascular disease, and chronic kidney disease. Insulin resistance, in particular, is a key player in the pathogenesis of CKMS and contributes to systemic inflammation and oxidative stress.

This interplay between the cardiovascular, kidney, and metabolic systems results in the exacerbation of disease burden, complicating treatment regimens and negatively affecting patient outcomes (Figure 1). The cumulative burden of multiple chronic diseases leads to substantial impacts on QoL, which we will explore in detail in subsequent sections.

Impact of Cardiovascular-Kidney-Metabolic Syndrome on Quality of Life

The impact of CKMS on quality of life is multi-dimensional, influencing physical, emotional, psychological, and social aspects of a patient's well-being (Figure 2). As patients with CKMS experience the progressive deterioration of their cardiovascular, renal, and metabolic health, they often face a range of physical symptoms, functional limitations, and psychological challenges that impair their overall quality of life (Petersson *et al.*, 2022).

Physical Well-being

The physical consequences of CKMS are far-reaching and directly contribute to the decline in QoL. Individuals with CKMS often experience symptoms such as fatigue, shortness of breath, chest pain, swelling, and limitations in physical activity. These symptoms are primarily due to the combined effects of cardiovascular disease, kidney dysfunction, and metabolic dysregulation.

- **Fatigue:** Fatigue is a common and debilitating symptom among patients with CKMS, largely due to anemia associated with kidney disease, poor cardiac output from heart failure, and metabolic disturbances. Chronic fatigue can lead to decreased mobility, reduced independence, and an inability to participate in daily activities, all of which severely impact QoL.

- **Dyspnea and Heart Failure:** In patients with CKMS, the coexistence of heart failure and kidney disease (cardiorenal syndrome) contributes to fluid retention, dyspnea, and reduced exercise tolerance. This impairs daily functioning and leads to greater dependency on caregivers, further compromising QoL.
- **Pain and Discomfort:** Patients with CKMS may suffer from pain due to cardiovascular events (e.g., angina, myocardial infarction) or renal complications (e.g., nephropathy, kidney failure). Pain exacerbates fatigue, reduces physical function, and often leads to psychological distress.
- **Reduced Physical Activity:** The combination of cardiovascular and kidney impairment limits the ability of individuals to engage in physical activity, leading

to deconditioning and increased disability. Reduced physical activity further exacerbates metabolic risk factors, including obesity, insulin resistance, and dyslipidemia.

Psychological Well-being

The psychological burden of CKMS is significant, as patients face not only the stress of managing multiple chronic conditions but also the fear of disease progression and the associated risk of disability or premature death.

- **Depression and Anxiety:** The chronic and often progressive nature of CKMS increases the risk of depression and anxiety. The uncertainty surrounding disease progression, frequent hospitalizations, and the financial burden of long-term treatment contribute to emotional distress (Tominari *et*

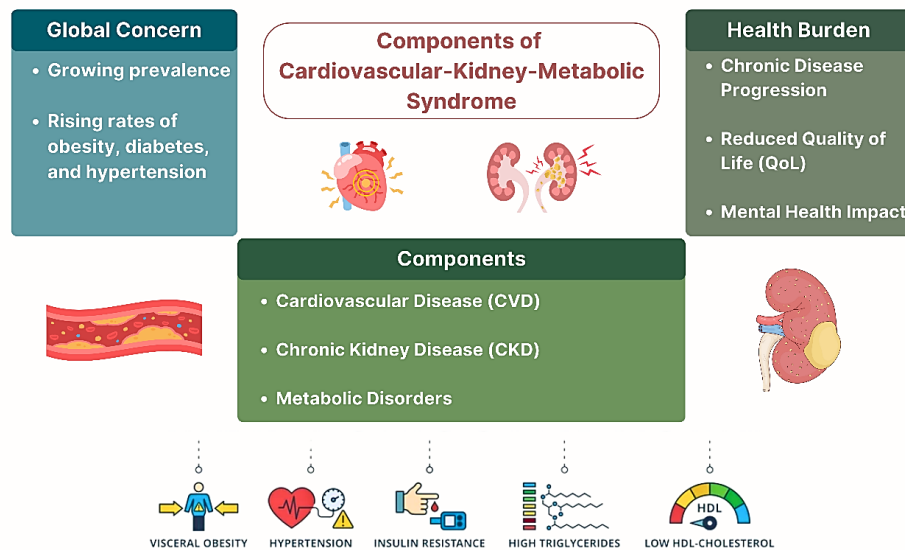


Figure 1: Components of Cardiovascular-Kidney-Metabolic Syndrome.



Figure 2: Impact of Cardiovascular-Kidney-Metabolic Syndrome on Quality of Life.

al., 2022). Studies show that depression is highly prevalent among patients with CKMS, which can further worsen cardiovascular and renal outcomes.

- **Cognitive Dysfunction:** Cognitive decline is increasingly recognized as an important aspect of CKMS. Both cardiovascular disease and chronic kidney disease are linked to a higher risk of cognitive impairment, which may be worsened by the systemic inflammation, metabolic dysregulation, and poor vascular health characteristic of CKMS. Cognitive decline reduces a patient's ability to manage their health, leading to poor adherence to treatment and a decrease in overall QoL.
- **Health-Related Quality of Life (HRQoL):** HRQoL refers to a patient's perception of their physical and mental health, which can be significantly impacted by CKMS. The burden of managing multiple chronic diseases often leads to a diminished sense of well-being, with patients reporting lower scores on HRQoL measures compared to those with single diseases or healthier individuals (Schwartz *et al.*, 2023).

Social Well-being

Patients with CKMS also experience significant social challenges due to the physical and psychological burdens of the disease. Social isolation, reduced participation in social activities, and financial strain are common consequences of CKMS.

- **Social Isolation:** Due to physical limitations, fatigue, and emotional distress, patients with CKMS may withdraw from social interactions. This can lead to feelings of loneliness, which exacerbate psychological symptoms and further diminish QoL.
- **Impact on Family and Caregivers:** The burden of CKMS extends beyond the patient, affecting family members and caregivers. Patients with CKMS often require assistance with daily tasks, medical appointments, and medication management, placing a significant strain on family dynamics (Chen *et al.*, 2024). Caregivers may experience stress, burnout, and financial hardship as a result of their caregiving responsibilities.
- **Economic Burden:** The economic burden of CKMS is substantial, with increased healthcare costs related to hospitalizations, medications, and long-term care. These costs often lead to financial stress, which in turn worsens the psychological and social impact on patients and their families.

Disease-Related Complications and Prognosis

The presence of multiple comorbidities in CKMS exacerbates the likelihood of severe complications, which can further impair quality of life. For instance, the risk of cardiovascular events such

as heart attacks or strokes is elevated, and kidney disease may progress to End-Stage Renal Disease (ESRD), requiring dialysis or kidney transplantation (Patel *et al.*, 2023). These complications often result in hospitalization, significant lifestyle changes, and a diminished ability to participate in normal activities.

Patients with CKMS are also at a higher risk of functional decline, increased disability, and premature death. The compounded burden of these complications leads to a reduction in the ability to live independently and can necessitate long-term care or assistance.

Current Approaches to Managing Quality of Life in CKMS

Given the significant impact of CKMS on quality of life, healthcare providers must adopt a holistic approach that addresses both the medical and psychosocial aspects of care. Effective management of CKMS requires integrated strategies that prioritize QoL while managing the underlying cardiovascular, kidney, and metabolic conditions.

Multidisciplinary Care

The management of CKMS benefits from a collaborative, multidisciplinary approach involving cardiologists, nephrologists, endocrinologists, dietitians, psychologists, and physical therapists (Kumar *et al.*, 2024). This team-based approach ensures that all aspects of the patient's health—physical, psychological, and social—are addressed. Coordinated care enhances patient outcomes and improves QoL by ensuring comprehensive management of the complex interplay of diseases.

Patient Education and Empowerment

Educating patients about their conditions, treatment options, and self-management strategies is essential for improving QoL. Empowering patients to take an active role in their care improves medication adherence, promotes lifestyle changes, and reduces anxiety related to disease management. Education programs should focus on managing comorbidities, recognizing symptoms early, and navigating the healthcare system.

Psychosocial Support

Psychosocial interventions, including counselling, Cognitive Behavioural Therapy (CBT), and support groups, can help patients cope with the emotional burden of CKMS. Addressing mental health issues such as depression and anxiety is crucial for improving QoL and preventing further decline in health outcomes. Psychological support for caregivers is also essential to mitigate burnout and maintain family well-being.

Lifestyle Interventions

Lifestyle modifications, including regular physical activity, dietary changes, smoking cessation, and weight management, are

foundational in improving the QoL of patients with CKMS. These interventions not only reduce cardiovascular and metabolic risks but also enhance physical functioning and psychological well-being.

Pharmacological Management

Pharmacological management remains essential for controlling the underlying cardiovascular, kidney, and metabolic conditions. Medications such as statins, antihypertensives, antidiabetic agents, and erythropoiesis-stimulating agents (for anemia in CKD) can help stabilize disease progression and reduce symptoms (Bennet *et al.*, 2023). Ensuring that patients are on the most effective treatment regimens tailored to their individual needs is critical for optimizing QoL.

Challenges and Barriers

Access to Healthcare

Disparities in healthcare access hinder early diagnosis and effective treatment of CKMS. Rural and underserved populations are particularly affected, emphasizing the need for equitable healthcare access.

Patient Adherence

Adherence to complex treatment regimens is challenging due to medication side effects, costs, and the burden of managing multiple conditions. Enhancing patient education and support is crucial.

Healthcare Infrastructure

Limitations in healthcare infrastructure, including the availability of specialized care, pose significant challenges. Strengthening healthcare systems is essential for managing CKMS effectively.

Future Directions for Managing CKMS

The future of managing Cardiovascular-Kidney-Metabolic Syndrome (CKMS) involves several promising areas of advancement, which aim to improve patient outcomes and Quality of Life (QoL). While current strategies provide valuable tools, further research and innovation are essential to refine and enhance these approaches (Figure 3).

Precision Medicine

Advances in genomics and personalized medicine offer significant potential for tailoring treatments to the individual genetic and molecular profiles of patients with CKMS. By identifying specific biomarkers and genetic variations that influence disease progression and treatment response, healthcare providers can develop more effective and targeted therapies. Precision medicine aims to move beyond the one-size-fits-all approach, allowing for personalized treatment plans that address the unique needs of each patient, ultimately optimizing therapeutic outcomes and minimizing adverse effects (Farooq *et al.*, 2023); (Zeng *et al.*, 2024).

Technology and Telemedicine

The rapid growth of telemedicine, remote monitoring, and digital health tools is transforming the management of CKMS. These

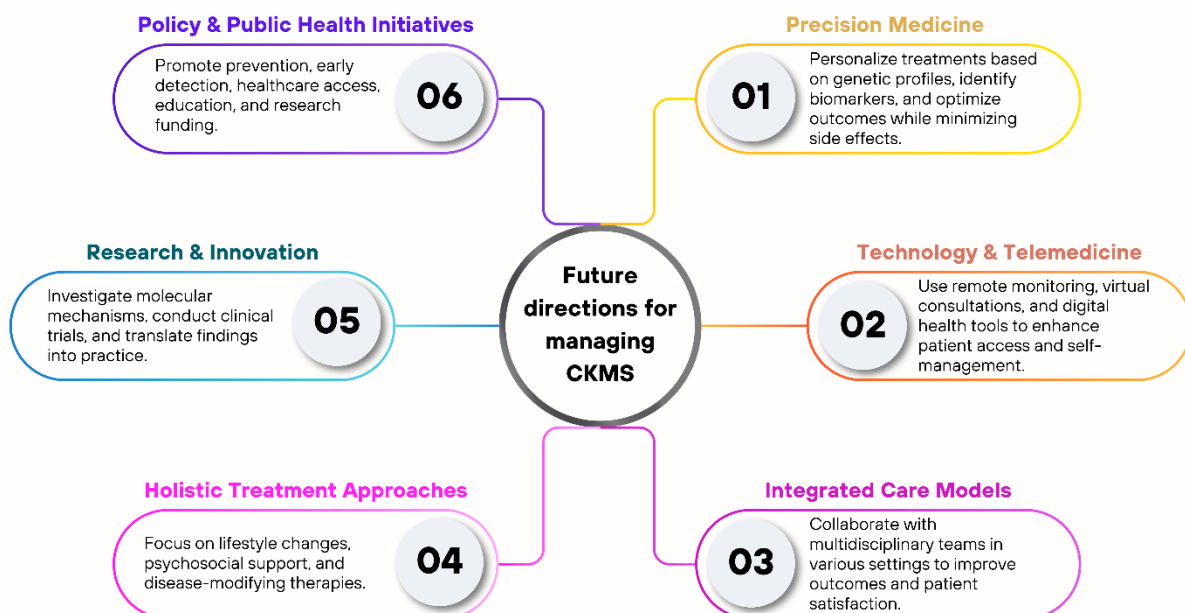


Figure 3: Future Directions for Managing CKMS.

technologies enable continuous monitoring of patients' vital signs, medication adherence, and lifestyle habits, providing real-time data to healthcare providers (Baker *et al.*, 2024). Telemedicine facilitates regular virtual consultations, reducing the need for frequent in-person visits and improving access to care for patients in remote or underserved areas. Digital health tools, such as mobile apps and wearable devices, empower patients to actively engage in their health management, enhancing adherence to treatment regimens and promoting self-care practices that improve QoL (Patel *et al.*, 2023).

Integrated Care Models

The development of integrated care models is crucial for optimizing clinical outcomes and QoL for patients with CKMS. These models bring together multidisciplinary teams, including cardiologists, nephrologists, endocrinologists, dietitians, and mental health professionals, to provide coordinated and comprehensive care. Integrated care models ensure seamless transitions between hospital, home, and community care settings, facilitating continuity of care and reducing the risk of fragmented treatment (Yuan *et al.*, 2024). This collaborative approach addresses the complex needs of CKMS patients, enhancing clinical outcomes and patient satisfaction.

Holistic Treatment Approaches

Future interventions for CKMS should continue to focus on holistic management, incorporating lifestyle changes, psychosocial support, and disease-modifying therapies. Lifestyle modifications, such as dietary adjustments, increased physical activity, and smoking cessation, are foundational to managing CKMS. Psychosocial support, including counselling and mental health services, addresses the emotional and psychological challenges associated with the syndrome. Disease-modifying therapies, including pharmacological treatments and advanced interventions like gene therapy and regenerative medicine, offer potential for more effective management of CKMS.

Research and Innovation

Ongoing research is essential to advance the understanding of CKMS and develop new therapeutic strategies. Investigating the molecular mechanisms underlying CKMS will help identify novel therapeutic targets and biomarkers for early detection and monitoring (Jackson *et al.*, 2023). Clinical trials and studies exploring the efficacy of new treatments and interventions are crucial for translating research findings into clinical practice.

Policy and Public Health Initiatives

Public health initiatives and policies focused on prevention, early detection, and management of CKMS are vital for reducing the burden of this syndrome. Community-based programs that promote healthy lifestyles, early screening, and education can help prevent the development and progression of CKMS. Policy efforts

to improve healthcare access, reduce disparities, and support research funding are essential for advancing the management of CKMS and improving patient outcomes (Williams *et al.*, 2024; Singh *et al.*, 2023).

CONCLUSION

Cardiovascular-Kidney-Metabolic Syndrome (CKMS) is a growing public health challenge affecting patients' quality of life. The interplay between cardiovascular, kidney, and metabolic diseases compounds disease burden, impacting physical, psychological, and social well-being. Addressing CKMS requires a comprehensive, patient-centered approach involving medical management, psychosocial support, lifestyle interventions, and coordinated care among multidisciplinary teams. This holistic approach is crucial for improving disease outcomes, alleviating symptoms, and enhancing well-being. Continued research into CKMS mechanisms is essential to refine treatment strategies and develop personalized interventions. Precision medicine, innovative technologies, and integrated care models will advance treatment options and quality of life for CKMS patients. By prioritizing medical and psychosocial needs, healthcare providers can help empower patients to lead healthier, more fulfilling lives despite CKMS challenges.

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ABBREVIATIONS

CKMS: Cardiovascular-Kidney-Metabolic Syndrome; **QoL:** Quality of Life; **CVD:** Cardiovascular Disease; **CKD:** Chronic Kidney Disease; **HRQoL:** Health-Related Quality of Life; **ESRD:** End-Stage Renal Disease; **NHANES:** National Health and Nutrition Examination Survey; **CBT:** Cognitive Behavioural Therapy.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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