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# THE IMPACT OF PHYSICAL ACTIVITY ON CHRONIC KIDNEY DISEASE: BENEFITS, SCIENTIFIC PROOFS, SAFETY, AND GUIDELINES FOR EXERCISE PRESCRIPTION

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## ABSTRACT

Chronic Kidney Disease (CKD) is a significant global health issue characterized by progressive loss of kidney function, impacting quality of life and increasing the risk of morbidity and mortality. This paper explores the multifaceted role of physical activity in managing CKD, focusing on its benefits, safety considerations, and best practices for exercise prescription, based on systematic reviews of literature sourced from PubMed and Google Scholar. While physical activity has been shown to offer substantial benefits, such as improved cardiovascular outcomes, enhanced physical function, and reduced inflammation, safety concerns are paramount. These include potential risks associated with exercise intensity and its effects on kidney function and overall health. The paper also evaluates best practices for integrating exercise into CKD management, based on recent evidence and expert recommendations. Our findings suggest that regular physical activity is a crucial component of CKD management, with significant potential to improve patient outcomes. However, tailored exercise programs that account for individual patient conditions and disease stages are essential to maximize benefits and minimize risks. This review underscores the need for ongoing research and refined guidelines to optimize exercise interventions for CKD patients, ensuring safe and effective integration into standard care practices.

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## KEYWORDS

CKD, Chronic Kidney Disease, Physical Activity, Aerobic Exercises, Resistance Training

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## CITATION

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## Introduction

Chronic Kidney Disease (CKD) is a broad term that encompasses various disorders affecting the structure and function of the kidneys. CKD is one of the leading causes of morbidity and mortality, with an estimated global prevalence of 13% (Hill et al., 2016). The primary indicator of kidney disease is a decrease in the estimated glomerular filtration rate (eGFR) (Barcellos et al., 2018a). The normal GFR range is 125 ml/min/1.73 m<sup>2</sup> in men, and in CKD, the eGFR falls below 60 ml/min/1.73 m<sup>2</sup>. The most severe form, end-stage kidney disease (ESKD), occurs when GFR drops below 15 ml/min/1.73 m<sup>2</sup>, necessitating dialysis or kidney transplantation to maintain patient survival.

The diagnosis of CKD can be based on the presence of kidney damage detected through laboratory or imaging studies, as well as the presence of risk factors such as diabetes, hypertension, and age over 60 years. Even with normal GFR, a physician may diagnose CKD based on other evidence of kidney damage, emphasizing the need for monitoring patients at risk for developing the disease (T. K. Chen et al., 2019).

In addition to significant epidemiological evidence supporting the role of physical activity in the prevention and treatment of diseases, physical inactivity is associated with higher incidences of non-communicable diseases such as coronary artery disease, type 2 diabetes, colorectal cancer, breast cancer, and reduced life expectancy (Böhm et al., 2017; Watson et al., 2018).

In the context of CKD, Exercise & Sports Science Australia (ESSA) highlights that physical inactivity may contribute to both the development and progression of CKD, as well as associated comorbidities (Exercise & Sports Science Australia, position statement on exercise and chronic kidney disease).

## Methodology

This review was conducted using systematic searches of PubMed and Google Scholar databases, focusing on studies published between 2007 and 2018. Meta-analyses and randomized controlled trials investigating the effects of physical activity on patients with chronic kidney disease (CKD) were included, with particular attention to interventions not requiring renal replacement therapy. The selected studies encompassed 927 CKD patients, many with comorbidities such as diabetes, hypertension, and dyslipidemia. Exercise protocols typically involved aerobic and/or resistance training performed three times per week, lasting approximately 30 minutes per session, at mild to moderate intensity. Outcomes assessed included estimated glomerular filtration rate (eGFR), proteinuria, blood pressure, hemoglobin, lipid profile, body mass index (BMI), exercise capacity, and health-related quality of life (HRQoL).

## Results

Evidence from meta-analyses and clinical trials shows that regular physical activity provides significant benefits for patients with chronic kidney disease (CKD). Although short-term interventions did not yield significant improvements in estimated glomerular filtration rate (eGFR), long-term aerobic training was associated with delayed disease progression and reduced need for renal replacement therapy. Exercise consistently improved cardiovascular outcomes, including lower blood pressure and enhanced aerobic capacity, and contributed to better physical functioning and quality of life, as measured by KDQOL-36 scores. Effects on lipid metabolism were mixed, but some studies indicated reductions in LDL cholesterol.

Overall, the findings suggest that the benefits of physical activity outweigh potential risks, underscoring its role as an essential component of CKD management. Current guidelines recommend at least 150 minutes of moderate-intensity exercise weekly, though stage-specific recommendations remain needed. The involvement of physiotherapists is highlighted as crucial for tailoring safe and effective programs to individual patient needs.

## Discussion

Given that chronic kidney disease (CKD) affects various areas of the body and impairs the functioning of different systems, a similar comprehensive approach should be taken to evaluate the impact of exercise on the body. To demonstrate the effects on specific health aspects, I will utilize the results of a meta-analysis by Florentino Villanego et al. (2020) (Villanego et al., 2020), which encompassed CKD patients from studies conducted between 2007 and 2018. The patients did not require renal replacement therapy, and more than half of the participants had chronic diseases. The studies collectively included 927 individuals suffering from CKD, with more than half also having comorbid conditions such as diabetes, hypertension, and dyslipidemia. In 14 of these studies, the training sessions were conducted three times per week for 30 minutes each, with mild to moderate intensity.

The analysis of grouped data from 429 patients demonstrated that physical activity does not significantly affect kidney function, as there were no statistically significant differences ( $p = 0.90$ ) in the estimated glomerular filtration rate (eGFR) between the intervention group and the control group at the end of the program. However, a long-term randomized controlled trial indicated that aerobic exercise delays the progression to end-stage chronic kidney disease (CKD) or the need to start renal replacement therapy (Pechter et al., 2014).

Contrary to the aforementioned meta-analysis, the meta-analysis by Zhang L et al. (2019) confirmed that eGFR increased by  $2.62 \text{ ml/min/1.73 m}^2$  following physical exercise therapy in patients with non-dialysis-dependent CKD (Zhang et al., 2019). Supporting the findings of Zhang's meta-analysis, Greenwood et al. (2015) conducted a study in which the rehabilitation group received resistance and aerobic training (3 days per week) for a 12-month period. The results showed that the rate of decline in eGFR in the rehabilitation group was slower than in the standard care group ( $p = 0.02$ ) (Greenwood et al., 2015).

Proteinuria was not influenced by physical activity, as evidenced by the analysis of 24-hour urine protein levels and the albumin-to-creatinine ratio (Hiraki et al., 2017; Howden et al., 2015a; Leehey et al., 2016).

According to a meta-analysis by Zhang et al. (2019), exercise therapy exerts an antihypertensive effect by lowering both systolic and diastolic blood pressure in patients with chronic kidney disease (CKD). This finding is corroborated by a study by Aoike et al. (2015), which demonstrated that aerobic training improved blood pressure. Conversely, some studies reported no effect of exercise on blood pressure in CKD patients, possibly due to variations in the type or intensity of the exercises performed.

The impact of exercise on increasing hemoglobin levels is unequivocally positive (Aoike et al., 2015; P. Y. Chen et al., 2010; Kosmadakis et al., 2012; Leehey et al., 2009).

The impact of physical activity on LDL cholesterol control in patients with chronic kidney disease (CKD) is contradictory. Studies reported no effect of aerobic or resistance exercise on LDL cholesterol levels (Albarrati et al., 2018; Headley et al., 2012; Van Craenenbroeck et al., 2015). However, the largest study included in the meta-analysis confirmed that physical exercise reduces LDL cholesterol levels (Albarrati et al., 2018)

A meta-analysis that included 275 participants with CKD examined the effects of aerobic exercise combined with resistance training on aerobic capacity. This analysis unequivocally indicates a significant positive impact on physical fitness, measured by peak oxygen uptake in exercise tests, and functional performance, measured by the 6-minute walk test (6MWT). There is also substantial evidence supporting the positive impact of combined aerobic and resistance exercises on body mass index (BMI) (Villanego et al., 2020).

Studies by (Aoike et al., 2015) and (Tang et al., 2017), utilizing the KDQOL-36 questionnaire, demonstrated improvements in health-related quality of life in CKD patients. The KDQOL-36 (Kidney Disease Quality of Life 36-item Short Form) is a validated questionnaire used to assess health-related quality of life, including both generic core scales and disease-specific scales addressing the burden of kidney disease, symptoms or problems, and effects of kidney disease on daily life. These studies showed a significant improvement in the quality of life ( $p = 0.02$ ).

The KDIGO 2024 guidelines emphasize the importance of physical activity in managing CKD, extending the principles established in the KDIGO 2022 diabetes management guidelines to all CKD patients. This extension is crucial as physical activity has been shown to improve overall health outcomes, including cardiovascular health, which is often compromised in CKD patients.

The recommendation for at least 150 minutes of moderate-intensity physical activity per week is grounded in evidence that suggests such activity levels can reduce the risk of cardiovascular events and improve physical fitness. However, the guideline wisely incorporates a personalized approach, advising that physical activity levels should be adjusted based on individual cardiovascular and physical tolerance, which is particularly pertinent for CKD patients who may have varying degrees of physical capability and comorbid conditions.

The guidelines also highlight the need to avoid sedentary behavior, recognizing the detrimental effects prolonged inactivity can have on health. For high-risk individuals, such as those prone to falls, the guidelines suggest tailored advice on exercise intensity and type, underscoring the importance of safety and appropriateness in physical activity prescriptions (Iatridi et al., 2025).

Finally, the emphasis on weight management for obese individuals with CKD aligns with the broader public health goal of combating obesity, which is a known risk factor for the progression of CKD and associated cardiovascular diseases. Encouraging weight loss in these patients can potentially improve their kidney function and overall health outcomes.

### **Aerobic Exercises**

Aerobic exercises enhance the antioxidant defense system, which is weakened in dialysis patients due to the excretion of uric acid and antioxidant vitamins (Corrêa et al., 2020).

Cognitive impairments are often evident across various domains: executive functions (judgment and planning), attention, language, memory, and visuospatial learning (Bronas et al., 2017). Cognitive impairments, particularly executive function deficits, are common in kidney disease, especially in patients with end-stage kidney disease (ESKD), and may be exacerbated by maintenance dialysis due to uremic toxin retention, recurrent cerebral ischemia, and inactivity (Chu & McAdams-DeMarco, 2019). Such impairments can lead to long-term adverse effects, including dementia and death (Bronas et al., 2017).

Studies have shown significant improvements in all areas of health-related quality of life in the training group, with notable reductions in anxiety, depression, and psychological stress after a 12-week training program (Watson et al., 2018). Another study investigated the impact of aerobic exercise on cognitive function in CKD patients through a 4-month program with three weekly sessions of 30–45 minutes at 65–75% maximum heart rate (HR<sub>max</sub>). Cognitive functions improved post-training (Stringuetta Belik et al., 2018). Examined the effects of a low-intensity home exercise program on cognitive function in dialysis patients, using the 6-minute walk test (6MWT) and the 5-times sit-to-stand test (5STS). Results indicated a decline in cognitive function in the control group over six months, while the active group maintained cognitive functions (Hiraki et al., 2017). Aerobic exercises enhance cardiovascular fitness and reduce the risk of cardiovascular

events, which are prevalent in CKD patients. Studies have demonstrated that aerobic training improves endothelial function and reduces arterial stiffness (Pei et al., 2019; Wilund et al., 2021).

Regular aerobic exercise improves physical capacity and endurance. Meta-analyses and systematic reviews have confirmed that aerobic exercise significantly improves peak oxygen uptake (VO<sub>2</sub> max) and physical functioning in CKD patients (Villanego et al., 2020; Weiner et al., 2023).

Aerobic exercise has anti-inflammatory effects. Studies have shown that aerobic training decreases levels of inflammatory markers such as C-reactive protein in CKD patients (Baião et al., 2023; Viana et al., 2014). However, contrasting results were found in a study (Abreu et al., 2017).

In another study, examined the effects of exercise on dialysis efficiency and physical function (Arazi et al., 2022a). Exercises were performed three times a week for five months. The results showed an 11% increase in dialysis efficiency following the training period (Parsons et al., 2006).

### **Resistance Training**

The results of resistance training studies have shown significant improvements in various health parameters for CKD patients. Resistance training was found to enhance the asymmetry of dimethyl arginine (ADMA), thus increasing the bioavailability of nitric oxide (NO) and improving redox state and sleep quality, which collectively reduced oxidative stress, inflammation, and ADMA levels (Corrêa et al., 2020). This indicates that resistance training not only mitigates inflammation but also combats reactive oxygen species (ROS) (Abreu et al., 2017).

Enhanced muscle strength from resistance training translates to better physical function and mobility. A systematic review by Yin J. et al. (2024) indicated that resistance training significantly improves physical performance in CKD patients (Yin et al., 2024). This finding was supported in study, where was also found that resistance training substantially enhances walking ability and physical performance in this patient population (Moinuddin & Leehey, 2008).

Resistance training improves metabolic health by increasing insulin sensitivity and glucose metabolism. In study it is demonstrated that resistance exercise enhanced insulin sensitivity and glycemic control in CKD patients, particularly those with diabetes (Barcellos et al., 2018b). This was corroborated by researches, who found similar improvements in insulin sensitivity and glycemic control following resistance training in CKD patients (Pan et al., 2025).

### **Safety**

Safety considerations are paramount when prescribing physical exercise to patients with chronic kidney disease (CKD). Studies indicate that a home-based exercise program, which includes a supervised training phase, is effective, adherent, and safe for CKD patients (Howden et al., 2015b). While moderate-intensity exercise is generally safe, high-intensity exercise can elevate biomarkers indicative of muscle and kidney damage, such as serum creatine kinase (CK), and urine myoglobin and creatinine levels (Honda et al., 2017; Spada et al., 2018). In study it is demonstrated that high-intensity interval training (HIIT) is practical and safe for CKD patients, providing similar benefits to moderate-intensity continuous training (MICT) in terms of exercise capacity and skeletal muscle protein synthesis (Beetham et al., 2019).

The findings of this study suggest that due to increased crystallization of uric acid and calcium oxalate, moderate-intensity exercise may heighten the risk of kidney stone formation without adequate fluid intake (Sakhaee, 2008). Physical activity can be safely recommended for patients in a stable condition, and the results of this meta-analysis support incorporating exercise as a fundamental component of CKD patient care (Corrêa et al., 2020).

### **Conclusions**

Research indicates that regular physical activity can have beneficial effects on patients with chronic kidney disease (CKD). These benefits include improved quality of life, a reduced risk of kidney disease progression, mitigation of some metabolic effects of CKD, and enhanced cardiovascular function. Increasing physical activity levels in individuals with CKD can significantly reduce their risk of cardiovascular diseases and improve their physical functioning, thereby preventing premature death (Arazi et al., 2022b). However, the KDIGO guidelines are not entirely explicit and serve more as an outline rather than a detailed protocol for prescribing physical exercise to CKD patients. Despite this, an increasing body of evidence supports the beneficial effects of physical exercise on clinical risk factors in individuals with CKD. As highlighted in a recent review, the advantages of physical activity for these patients significantly outweigh the risks associated

with inactivity. Consequently, integrating regular physical exercise into the standard care regimen for CKD patients should be considered to enhance patient outcomes and overall health.

The current KDIGO (Kidney Disease: Improving Global Outcomes) guidelines advocate for a universal approach to exercise recommendations for CKD patients, without differentiating between the stages of the disease. While this general approach provides a foundational framework, it underscores the need for more targeted research that investigates the impact of physical activity on CKD patients at various stages of renal insufficiency. Tailored guidelines based on the severity of CKD could lead to more precise exercise prescriptions, ensuring safety and efficacy for patients at different disease stages.

More specific guidelines would likely enhance physician confidence in prescribing exercise regimens to CKD patients, as they would be grounded in robust scientific evidence. This, in turn, could lead to increased adoption of exercise recommendations in clinical practice, ultimately improving patient outcomes. Detailed, stage-specific exercise guidelines could help mitigate concerns regarding the safety of physical activity for CKD patients, encouraging more healthcare providers to incorporate physical exercise into their treatment plans.

Furthermore, the role of physiotherapists in the management of CKD patients cannot be overstated. Physiotherapists possess specialized knowledge in exercise science, which surpasses that of many general healthcare providers. Their expertise is critical in tailoring exercise programs to individual patient needs, monitoring progress, and adjusting activities based on the patient's current health status. Physiotherapists can work closely with patients, providing motivation and ensuring adherence to exercise regimens. This ongoing interaction can facilitate real-time modifications to exercise plans, accommodating changes in the patient's condition and ensuring the continued effectiveness and safety of the exercise intervention.

The integration of physiotherapists into the multidisciplinary care team for CKD patients could enhance the overall management strategy. Their direct involvement in patient care, from initial assessment through to ongoing monitoring and adjustment of exercise programs, would ensure that physical activity is optimized for each patient. This approach would also allow for immediate responses to any adverse reactions or changes in patient health, further increasing the safety and effectiveness of exercise interventions.

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