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THE ROLE OF PHYSICAL ACTIVITY IN SLOWING PROGRESSION OF CHRONIC KIDNEY DISEASE - A NARRATIVE REVIEW

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ABSTRACT

Chronic kidney disease (CKD) represents a substantial and growing global health dysfunction. The rising occurrence driven by aging populations and increasing rates of metabolic disorders. This disease causes kidney function to slowly get worse. In the early stages, there are often no symptoms, so it is usually diagnosed only after significant kidney damage has already happened. Current clinical and public health strategies prioritize early identification and risk reduction. Modifiable lifestyle factors - such as regular physical activity and effective weight management - play an important role in slowing disease progression and reducing the risk of end-stage renal disease requiring dialysis or kidney transplantation. This narrative review aims to investigate the relationship between physical activity and the slowing of chronic kidney disease progression in patients. This narrative review evaluates scientific literature published over the past 25 years. Relevant data were obtained from studies indexed in the PubMed and Scopus databases. Cohort studies, systematic reviews, and meta-analyses published in English were included. Across the analyzed studies, greater engagement in physical activity was consistently linked to lower all-cause mortality in patients with chronic kidney disease. Active individuals tended to report better quality of life and exhibited a more gradual reduction in kidney function compared to those with lower activity levels, which indicates that regular physical activity is associated with improved patient prognosis. Physical activity has been consistently connected to lower death rates in people with chronic kidney disease. In addition, higher levels of physical activity relate to better quality of life and a slower rate of disease progression when compared to inactive patients.

KEYWORDS

Physical Activity, Chronic Kidney Disease (CKD), Exercise Training, GFR, Mortality

CITATION

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1. Introduction

1.1 Definition

Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function that are present for a minimum of 3 months with implications for health. Markers of kidney damage include albuminuria (ACR $\geq$30 mg/g [$\geq$3 mg/mmol]), urine sediment abnormalities, persistent hematuria, electrolyte or other abnormalities due to tubular disorders, histological abnormalities, structural abnormalities on imaging, or a history of kidney transplantation [1]. It is a condition that gets worse over time, often without any noticeable symptoms. As a result, patients often do not realize they are close to kidney failure [1].

1.2 Epidemiology

Chronic kidney disease (CKD) is a serious health issue that is becoming more common around the world. In 2021, over 850 million people were affected by some type of kidney disease, which is about twice as many as those living with diabetes [1,3]. More than 1 in 7 adults in the United States (approximately 14% or 37 million people) are estimated to have CKD [2]. The disease is significantly more common in older adults. Around 34% of people aged 65 or older compared to just 6% of those aged 18–44 are reported to suffer from the CKD. The most striking epidemiological fact is that about 9 in 10 adults with CKD do not know they have it [1,2,4].

1.3. Clinical meaning

Nowadays, CKD is recognized not just as a kidney issue but as a substantial risk-enhancing factor for cardiovascular disease. All stages of chronic kidney disease are linked to elevated risks of cardiovascular complications, early mortality, and reduced quality of life [3,5].

CKD has risen from the 19th leading cause of death in 1990 to the 11th leading cause of death today [1]. It is inseparably linked to the "epidemics" of diabetes and hypertension. Approximately 38% of adults with diabetes and 21% of those with high blood pressure also have CKD [2]. Since CKD cannot be cured after it develops, there is a focus on finding it early and encouraging lifestyle changes like being active and managing weight. These steps can help slow the disease and may prevent the need for dialysis or a transplant [1,2,3].

1.4 The role of CKD in impairing physical function

CKD has a big effect on physical health, and this gets worse as the disease moves toward End-Stage Renal Disease (ESRD). In the early stages, people might feel a little tired or notice some swelling. In later stages, symptoms can include constant tiredness, fluid overload, shortness of breath and a build-up of waste products (uremia) [6].

Patients experience impairments in physical functioning, such as bodily pain and role limitations. Physical health problems restrict their ability to perform daily activities. Living with CKD requires managing difficult treatments, fluid restrictions, and a dependence on technology (such as dialysis), all of which diminish a patient's autonomy and capacity for physical activity [6]. Research consistently shows that CKD patients have much lower physical health scores compared to the general population. These impairments are influenced by the specific therapeutic strategy (hemodialysis, peritoneal dialysis, or transplantation) and the presence of other comorbidities [6, 24].

2. Methodology

This systematic review evaluates scientific literature published over the past 25 years. Relevant data were retrieved from studies indexed in the PubMed, Scopus databases. The search included key terms such as "chronic kidney disease (CKD)," "physical activity," and "mortality," as well as related combinations of these terms. Cohort studies, systematic reviews, and meta-analyses published in English were included. Titles and abstracts were screened for relevance, and full-text articles were assessed based on predefined inclusion and exclusion criteria to ensure the selection of appropriate studies.

3. Research results

3.1. Poor physical function and physical inactivity in patients with CKD

People with chronic kidney disease often have a sedentary lifestyle, which can be caused by personal and disease-related factors. A recent cross-sectional study including adult patients (>18 years) with CKD stages 2–4 reported very low levels of physical activity in this population [7]. Across the progression of the disease, the research found a decrease in physical activity in patients (figure 1). An investigation study by Wilkinson et al. 2021 reported that physical activity levels drastically declined from CKD stage 3 (17% active) to stages 4 and 5 (11% active) [8].

Research indicates that sarcopenia and physical inactivity progress together in a negative feedback loop [9]. Sarcopenia, characterized by the loss of skeletal muscle mass and strength, induces physical inactivity through the loss of physical function [9]. In turn, physical inactivity and risk factors accelerate muscle loss, protein degradation, and decreased muscle regeneration, which lead to sarcopenia. The consequences of sarcopenia are severe for the patient, including increased infections risk, reduced health-related quality of life, and an increased risk of cardiovascular diseases (figure 2).

The prevalence of sarcopenia increases as CKD stages progress: it is reported at approximately 4.3% in Stage 1, 6.3% in Stage 2, and rises to 15.4% in Stages 3–5. In elderly hemodialysis patients, the prevalence is much higher, ranging from 45% to 63% [9].

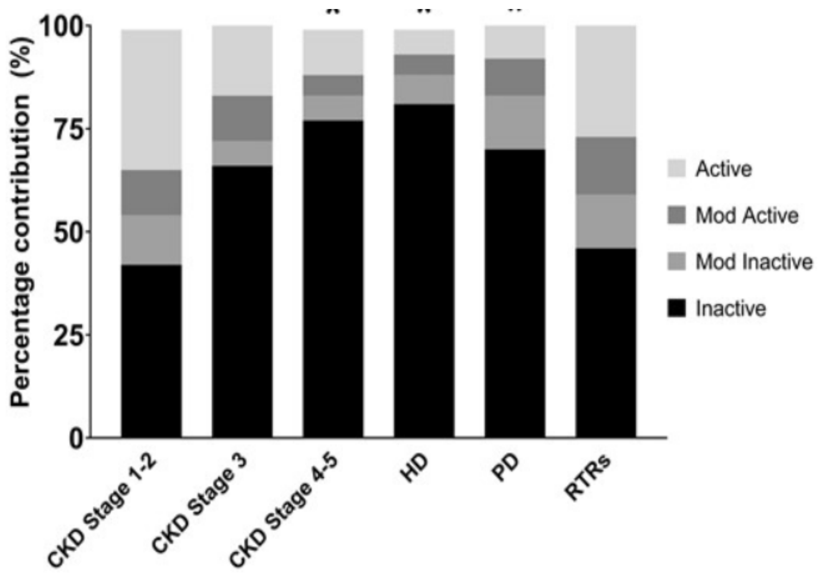

Fig. 1. Reduction in physical activity across disease progression (reproduced from Wilkinson et al., 2019).

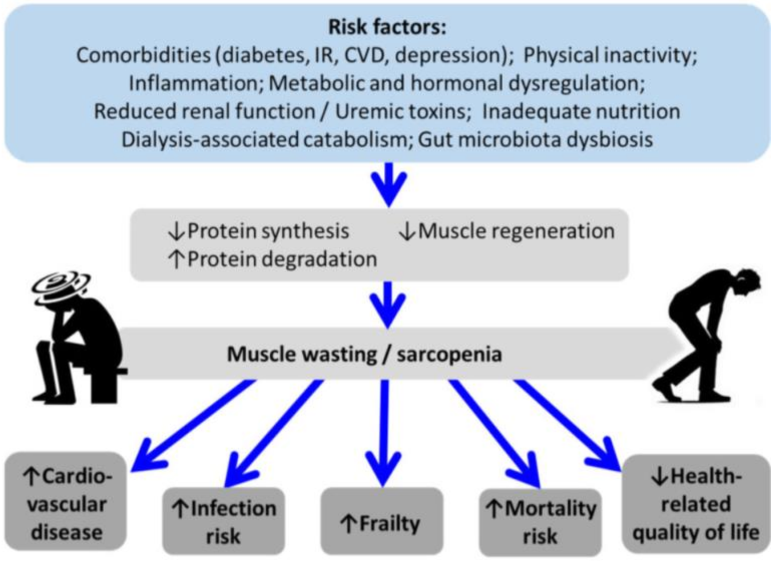

Fig. 2. Pathophysiology of sarcopenia in chronic kidney disease (reproduced from Tsai CC et al., 2025).

3.2 Association between higher mortality and physical inactivity in patients with CKD.

Previous research has explored the association between increased mortality and physical inactivity in patients with CKD. The analysis shows that impaired physical function and reduced physical activity levels correlated with higher mortality [10]. CKD patients have significantly higher inactivity rates (28.0%) compared to the non-CKD population (13.5%). Sedentary behavior is associated with a 1.62 times higher mortality risk [9].

Investigations consistently identify sarcopenia and inactivity as strong independent predictors of mortality in the CKD population. Sarcopenia, evaluated by low muscle mass, decreased gait speed, and low handgrip strength, is correlated with an increased risk of death in both pre-dialysis and hemodialysis patients [9,10]. Sarcopenia is linked to worse kidney outcomes. In particular, lower handgrip strength has been shown to predict progression to End-Stage Renal Disease (ESRD) [9].

Most observational studies reported a significant reduction in all-cause mortality as physical activity levels increased. When comparing the most active groups to the least active groups, the Hazard Ratio (HR) for death ranged from 0.42 to 0.70, representing a 30% to 58% reduction in mortality risk. These results were consistent across both hemodialysis and kidney transplant population [11].

3.3. Influence of physical activity on kidney function in patients with CKD.

The glomerular filtration rate (GFR), and more specifically its estimated value (eGFR), is a key parameter in the diagnosis, monitoring, and staging of chronic kidney disease (CKD). Several studies have explored the relationship between physical activity and GFR.

The meta-analysis of 11 randomized controlled trials (RCTs), involving 362 participants, evaluates the role of aerobic exercise in patients with CKD stages 3–4. It was found that aerobic training has a small but significant beneficial effect on eGFR compared to standard care [12]. On average, patients participating in aerobic exercise programs showed an increase in eGFR of +2.16 ml/min per 1.73m². These improvements were observed following aerobic training programs with a mean duration of 35 weeks. The beneficial effect on eGFR was smaller in elderly patients (≥60 years) compared to younger subjects. When studies with the oldest participants were excluded, the improvement in eGFR rose to +3.43 ml/min per 1.73m² [12]. The other studies found a significant association between higher levels of physical activity and a slower rate of decline in estimated glomerular filtration rate (eGFR) [13,14].

Participants who were physically inactive showed an eGFR decline of 9.6% per year, while those who engaged in more than 150 minutes of activity per week experienced a slower decline of 6.2% per year [13]. For every additional 60 minutes of weekly physical activity, there was an associated 0.5% slower annual decline in eGFR. Results were consistent even when looking only at walking. Participants who walked ≥150 minutes per week had an annualized eGFR decline of 5.3% compared to 8.6% in those who did not walk at all [13].

Meta-analysis by Zhang L et al. 2019 shows that exercise therapy leads to a statistically significant average increase in eGFR of 2.62 ml/min/1.73m² compared to control groups [14]. The most notable improvements were noted in short-term interventions (<3 months), which saw an average increase of 5.22 ml/min/1.73m² [14].

3.4. Types of physical activity and their impact on clinical outcomes

Physical activities can vary. Among people with chronic kidney disease, the most popular activities are cycling, walking, exercise, housework, and gardening (figure 3).

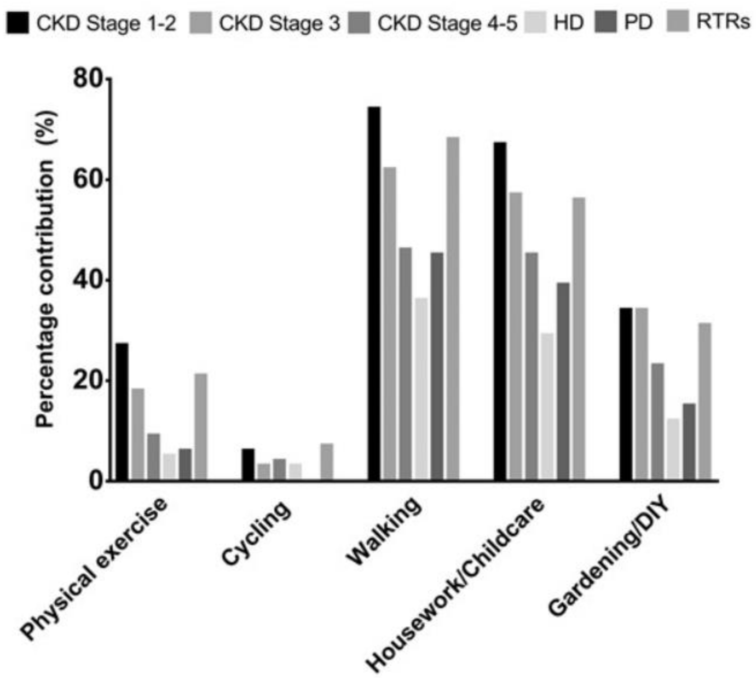

Fig. 3. *Prevalence of the physical activities among patients with CKD (reproduced from Wilkinson et al., 2019).*

3.4.1. Aerobic Exercise

Regular aerobic training (cycling, walking, swimming) is associated with improving aerobic capacity (VO2peak) and potentially slowing the decline of the estimated glomerular filtration rate (eGFR) [12,15,16]. Many people with CKD have trouble tolerating exercise, as shown by their low VO2 peak levels. This problem is caused by several factors, such as renal anemia, malnutrition, vascular issues, and polyneuropathy [12]. A meta-analysis of randomized controlled trials involving CKD stages 3–4 found that aerobic training significantly improves VO2 peak compared to standard care. Aerobic training programs (averaging 32 to 35 weeks) improved VO2 peak by 2.39 ml/kg/min compared to control groups [12].

A meta-analysis of 12 randomized controlled trials with 410 participants found that regular aerobic exercise improves several measures of kidney function in people with chronic kidney disease. Aerobic exercise led to better estimated glomerular filtration rate, lower serum creatinine, reduced 24-hour urine protein, and lower blood urea nitrogen [23]. It also reduced oxidative stress in the kidneys and boosted their antioxidant capacity, with moderate-intensity exercise showing the most benefit [23]. Exercise may also help prevent kidney scarring and improve kidney structure by affecting the TGF-β1/Smad signaling pathway [23].

3.4.2. Resistance Training

Meta-analysis results show that resistance exercise increases fat-free mass (muscle mass), with a weighted mean difference of 6.53 kg, which serves as a key indicator of improved muscle function and strength [17]. Resistance training reduces both glycosylated hemoglobin (HbA1c) and C-reactive protein (CRP) in patients with chronic kidney disease, marking a substantial improvement in their metabolic and inflammatory health [17]. A lower HbA1c ratio suggests that CKD patients can better manage their blood sugar and metabolic condition, which helps alleviate the progression of the disease [17]. Decrease in CRP is considered clinically meaningful because it is a major predictor and risk factor for cardiovascular disease (CVD). Since CVD is the leading cause of mortality among CKD patients, a reduction in CRP indicates a relief of the inflammatory response and a decreased risk of life-threatening cardiovascular complications [17].

Randomized controlled trial shows that it also helps preserve bone health by stimulating bone alkaline phosphate, which prevents bone loss common in CKD patients [19].

3.5. General impact of physical activity on the health in patients with CKD

The sources suggest that physical activity benefits CKD patients through several biological and systemic pathways (figure 4) [25]:

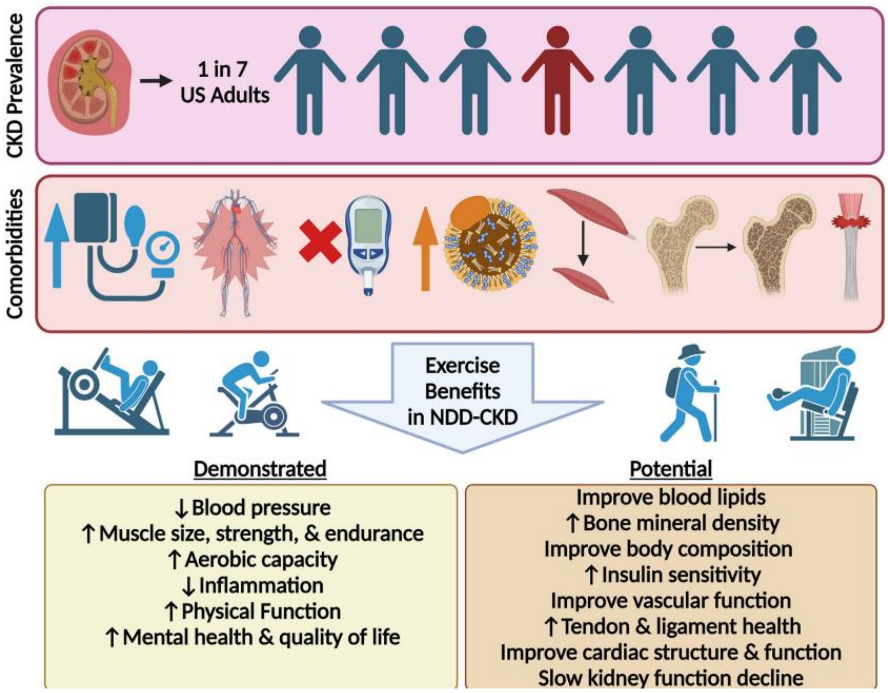

Fig. 4. *Exercise benefits in NDD-CKD (reproduced from Hayden, et al., 2024)*

3.5.1. Anti-inflammatory effects: Regular activity provide anti-inflammatory benefits, countering the "inflammation-malnutrition" cycle common in CKD that drives renal progression [20].

3.5.2. Vascular health: Exercise can increase nitric oxide and improve vascular endothelial function, which protect both heart and kidney health [20, 21].

3.5.3. Psychological benefits: Even light physical activity can increase self-confidence and reduce symptoms of depression, which is vital for patients with chronic illness [20].

3.5.4. BMI changes: Aerobic exercise training lasting an average of 32 weeks resulted in a decrease in BMI of 0.73 kg/m² compared to standard care [12]. A previous meta-analysis of RCTs in non-dialysis CKD patients showed that exercise therapy resulted in a substantial reduction in BMI of 1.32 kg/m² across the analyzed studies [14].

3.5.5. Hospitalization and musculoskeletal health: Regular physical activity helps lower the risk of being hospitalized for fractures. People who exercise at least once a week have a 24% lower chance of hospitalization from fractures than those who do not exercise. This is because exercise improves bone mineral density and helps prevent falls [11,19].

3.5.6. Systolic blood pressure: Physical activity acts as a potent anti-hypertensive tool for managing CKD-related complications. Meta analysis shows that exercise training significantly reduces systolic blood pressure by an average of 5.61 mmHg [14]. Unlike renal function, which showed variations based on time, the reduction in SBP remains significant regardless of the duration of the exercise intervention, whether it is less than 6 months or up to a year. These improvements are likely driven by enhanced endothelium-mediated vasodilation and a reduction in sympathetic nervous system activity [14]

3.6. Impact of physical activity on disease progression

Physical inactivity is closely associated with the risk of disease progression, specifically the need to begin dialysis:

3.6.1. Handgrip strength: Higher handgrip strength was significantly associated with a decreased risk for commencing dialysis (Hazard Ratio: 0.89). This correlation remained consistent regardless of the patient's sex or serum albumin levels [20]. Reduced handgrip strength and a lower level of regular walking are associated with a higher risk of initiating dialysis [26].

3.6.2. 2-minute step test: The 2-minute step test is a functional exercise assessment used to evaluate aerobic endurance by counting how many times a person can raise their knees to a specified height within 2 minutes [20]. High performance in the 2-minute step test was also a strong indicator of reduced risk for commencing dialysis [20].

3.6.3. 30-second chair-stand test: The study found that lower extremity endurance is a strong predictor of major medical complications. Researchers measured muscle endurance with the 30-second chair-stand test, counting how many times each patient could stand up fully in 30 seconds [27]. Each additional stand was linked to a 35% lower risk of cardiovascular events [20]. Higher scores on the chair-stand test also predicted a 16% lower risk of first-time hospitalizations [20].

3.7. Physical activity in dialysis patients

For patients undergoing hemodialysis, research identifies several critical clinical outcomes that are directly influenced by physical activity levels [22].

Higher physical activity on both dialysis and non-dialysis days is independently associated with lower risks of mortality and cardiovascular hospitalizations. Crucially, having high activity levels on only one type of day (for example, being active only on non-dialysis days) does not improve clinical outcomes. Patients who are active on one day but sedentary on the other remain at higher risk for mortality and cardiovascular events [22].

Patients usually take fewer steps on dialysis days than on non-dialysis days because of the time spent in treatment and the fatigue that follows. Looking at physical activity separately for dialysis and non-dialysis days helps predict a patient's prognosis better than just measuring total weekly activity. There is a strong inverse link between physical activity and fatigue severity, so patients who are more active often report less fatigue [22]. To lower the risk of death and hospitalization, dialysis patients need to stay active throughout the whole week, not just on days when they are not receiving treatment [22]. In accordance with the findings, the influence of different types of exercise on patients undergoing haemodialysis, both aerobic training and combined training significantly improve aerobic capacity compared to no exercise. Combined training resulted in an improvement of 5.00 ml/kg/min. While aerobic training showed an improvement of 3.35 ml/kg/min compared to the control group [23]. Combined training is the only modality that significantly reduces both systolic and diastolic blood pressure compared to a control group. According to the network meta-analysis, combined training was superior to the control for systolic blood pressure and superior to both aerobic training and the control for diastolic blood pressure. It is ranked as the most effective modality for blood pressure control [23].

4. Discussion

This narrative review observed a correlation between physical activity and a slower progression of kidney disease. As physical activity has a comprehensive impact on clinical indicators, an improvement in the overall prognosis for patients was noted.

There is a correlation between disease progression and reduced physical activity, which leads to a number of adverse consequences [7,8,9]. One of the factors associated with poor renal outcomes is sarcopenia, which is a direct consequence of reduced physical activity in patients [9]. The present study highlights that an increase in GFR has been observed in patients who engage in aerobic exercise, suggesting a slowing of the progression of chronic kidney disease [13]. Aerobic exercise also led to an improvement in VO_2 [12].

Physical activity benefits people with CKD through several biological and systemic processes. Regular exercise can reduce inflammation, which may help slow disease progression. It also improves blood vessel function, supporting both heart and kidney health. Even low-intensity activity can boost mood and self-confidence, which matters for managing chronic illness. Over time, aerobic exercise can also lower BMI, helping to reduce overall health risks [12,20].

The findings suggest that physical performance is closely associated with the risk of disease progression and adverse clinical outcomes in patients with CKD. Higher handgrip strength and better cardiorespiratory fitness, as measured by the 2-minute step test, were consistently linked to a lower likelihood of initiating dialysis [20]. Lower extremity endurance, assessed by the 30-second chair-stand test, emerged as a strong predictor of major clinical events, with better performance associated with reduced risks of both cardiovascular events and hospitalization. These results highlight the potential role of functional fitness measures as clinically relevant indicators of prognosis in this population [20].

The findings indicate that, in patients undergoing maintenance hemodialysis, the impact of physical activity on clinical outcomes depends not only on overall volume but also on its consistency across dialysis and non-dialysis days [22]. Higher activity levels on both types of days were independently associated with reduced risks of mortality and cardiovascular hospitalization, whereas activity limited to only one type of day did not confer similar benefits. Patients who remained inactive on either dialysis or non-dialysis days continued to exhibit elevated risk [22]. Despite lower activity levels typically observed on dialysis days due to treatment burden and fatigue, consistent engagement in physical activity throughout the week appears essential for improving prognosis [22]. Additionally, an inverse relationship between physical activity and fatigue severity was observed, suggesting that more active patients experience less fatigue. These findings underscore the importance of sustained and distributed physical activity in this population [22]. Combined training (a mix of aerobic and resistance exercises) is the most effective type of exercise for increasing both aerobic capacity and blood pressure control in people requiring haemodialysis for end-stage renal disease [23].

5. Conclusions

A growing amount of evidence indicates that regular physical activity is strongly associated with lower mortality rates in individuals with chronic kidney disease. Patients who engage in higher levels of activity tend to report better overall quality of life, improved physical functioning and mental well-being. Physical activity has been linked to a slower decline in renal function, suggesting a potential role in delaying disease progression. These benefits may be partly explained by improvements in cardiovascular health, reduction of systemic inflammation, and better metabolic control. The findings support physical activity as an important non-pharmacological strategy in the comprehensive management of CKD.

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Project administration: Iia Zhaharina, Yaryna Manila, Yulia Dubowa

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