



NICOLAUS COPERNICUS  
UNIVERSITY  
IN TORUŃ



**Journal of Education, Health and Sport. eISSN 2391-8306.**

**Journal Home Page**

**<https://apcz.umk.pl/JEHS/index>**

WOŁOSZCZUK, Tomasz, GRACA, Zofia, KOŁODZIEJ, Jakub, SKOWRONEK, Aleksandra, JEZIORNA, Julia, SIUDMAK, Elżbieta, SAWINA, Agnieszka, IWANICKI, Adam, ŁABUŚ, Maciej and SKAWIŃSKA, Aleksandra. **The Role of Physical Activity in Patients Undergoing Hemodialysis for Chronic Kidney Disease: Implications for Clinical Outcomes and Quality of Life - A Review.** *Journal of Education, Health and Sport.* 2026;89:69905. eISSN 2391-8306. <https://doi.org/10.12775/JEHS.2026.89.69905>

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences). Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu). © The Authors 2026; This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland  
Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike. (<http://creativecommons.org/licenses/by-nc-sa/4.0/>) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.  
The authors declare that there is no conflict of interests regarding the publication of this paper.  
Received: 17.03.2026. Revised: 28.03.2026. Accepted: 28.03.2026. Published: 28.03.2026.

## **The Role of Physical Activity in Patients Undergoing Hemodialysis for Chronic Kidney Disease: Implications for Clinical Outcomes and Quality of Life - A Review**

Wołoszczuk Tomasz, Graca Zofia, Kołodziej Jakub, Skowronek Aleksandra, Jeziorna Julia, Siudmak Elżbieta, Sawina Agnieszka, Iwanicki Adam, Łabuś Maciej, Skawińska Aleksandra

Tomasz Wołoszczuk

ORCID: <https://orcid.org/0009-0001-8168-6213>

e-mail: [controlux63@gmail.com](mailto:controlux63@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Zofia Graca

ORCID: <https://orcid.org/0009-0000-8286-4862>

mail: [zofia.graca0708@gmail.com](mailto:zofia.graca0708@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Jakub Kołodziej

ORCID: <https://orcid.org/0009-0003-7876-6524>

e-mail: [jakkol2723@gmail.com](mailto:jakkol2723@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Aleksandra Skowronek

ORCID: <https://orcid.org/0009-0008-5303-4980>

e-mail: [skowronekalexa@gmail.com](mailto:skowronekalexa@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Julia Jeziorna

ORCID: <https://orcid.org/0009-0003-2576-5288>

e-mail: [julia.jeziorna@o2.pl](mailto:julia.jeziorna@o2.pl)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Elżbieta Siudmak

ORCID: <https://orcid.org/0009-0001-7460-0266>

mail: [elasiudmak742@gmail.com](mailto:elasiudmak742@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Agnieszka Sawina

ORCID: <https://orcid.org/0009-0008-0111-054X>

mail: [sawina.agnieszka13@gmail.com](mailto:sawina.agnieszka13@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Adam Iwanicki

ORCID: <https://orcid.org/0009-0009-1345-3416>

e-mail: [a.iwanicki@o2.pl](mailto:a.iwanicki@o2.pl)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Maciej Łabuś

ORCID: <https://orcid.org/0009-0006-9599-7967>

e-mail: [maciej.wojciech.labus@gmail.com](mailto:maciej.wojciech.labus@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Aleksandra Skawińska

ORCID: <https://orcid.org/0009-0000-1328-1479>

e-mail: [aleksandra.dorota.skawinska@gmail.com](mailto:aleksandra.dorota.skawinska@gmail.com)

Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland  
Poniatowskiego 15, 40-055 Katowice, Poland

Corresponding Author

Tomasz Wołoszczuk, e-mail: [controlux63@gmail.com](mailto:controlux63@gmail.com)

**Abstract:**

**Introduction and purpose:** End-stage kidney disease represents a major health burden and is associated with reduced physical capacity and a significant decline in patients' quality of life. Hemodialysis, which for many individuals remains the only life-sustaining treatment option, is accompanied by numerous health-related consequences, including fatigue, muscle weakness, reduced levels of physical activity, and impaired psychological well-being. The aim of this article was to summarize the current knowledge regarding the role of physical activity in the management of patients undergoing hemodialysis and to evaluate its potential impact on clinical outcomes and quality of life.

**State of Knowledge:** Regular physical activity in hemodialysis patients may contribute to improvements in physical performance, muscle strength, metabolic parameters, and overall functional capacity. An increasing number of studies also indicate that exercise can positively influence health-related quality of life and reduce depressive symptoms in this population. The most favorable outcomes are typically observed in training programs of moderate intensity lasting at least several weeks.

**Conclusions:** Physical activity appears to be a promising adjunctive component of therapy in patients undergoing hemodialysis, providing benefits for both physical and mental health. The incorporation of appropriately designed exercise programs into standard care for patients with chronic kidney disease may improve functional capacity, quality of life, and overall prognosis. Nevertheless, further research is needed to establish standardized and safe exercise strategies tailored to this patient population.

**Key Words:** Physical activity; Chronic kidney disease; Hemodialysis, Mental health, Quality of life

**Content:**

1. Introduction
2. Pathophysiological Basis for Exercise in Hemodialysis Patients
3. Types of Physical Activity in Hemodialysis Patients
  3. 1 Resistance Training in Hemodialysis Patients
  3. 2 Aerobic Training in Dialysis Patients
4. Clinical Outcomes Associated with Physical Activity in Hemodialysis Patients
5. Impact on Quality of Life and Psychological Well-Being
6. Conclusions
7. References

## Introduction

Chronic kidney disease (CKD) represents a major global health burden [1]. CKD is defined as kidney damage or decreased kidney function persisting for more than three months. Abnormalities such as proteinuria or hematuria, cysts detected on renal imaging, and a reduction in glomerular filtration rate (GFR) below 60 mL/min indicate kidney damage. Based on the level of GFR, CKD is classified into five stages [Table 1]. The fifth and final stage corresponds to end-stage kidney disease (ESKD), which requires renal replacement therapy (RRT) [2]. According to global estimates, approximately five million individuals currently receive RRT in the form of dialysis or kidney transplantation [3]. The most common causes of CKD in adults include diabetic nephropathy, glomerulonephritis, hypertensive nephropathy, and atherosclerosis. Depending on the underlying etiology, CKD may present with a wide range of symptoms. Common manifestations of kidney failure include fatigue, weight loss, anemia, edema, polyuria or anuria, flank pain, bone fractures, and menstrual disturbances [4,5]. In suspected CKD, serum creatinine levels are measured and used to estimate GFR in order to determine the stage of the disease. Additional diagnostic procedures include urinalysis and renal ultrasonography [6]. Patients with end-stage kidney disease (stage 5 CKD; eGFR <15 mL/min/1.73 m<sup>2</sup>) require renal replacement therapy (RRT). There are three main RRT strategies - kidney transplantation, hemodialysis, and peritoneal dialysis [7]. Kidney transplantation is considered the most effective treatment option because it most closely restores physiological kidney function; however, it requires a suitable donor, lifelong immunosuppressive therapy, and appropriate patient eligibility for transplantation [8,9]. Hemodialysis is the most commonly used method of renal replacement therapy worldwide. Although highly effective, it requires vascular access through an arteriovenous fistula and frequent visits to dialysis centers. The procedure is typically performed three times per week, with each session lasting approximately four to five hours. In contrast, peritoneal dialysis can be performed at home and offers greater patient independence. This method utilizes the peritoneum as a natural dialysis membrane; dialysate is introduced into the abdominal cavity via a catheter, allowing the exchange of substances between the blood in peritoneal vessels and the dialysis fluid. The used dialysate is then drained and replaced with fresh solution. One of the major limitations of peritoneal dialysis is the increased risk of peritonitis [9,10].

Renal replacement therapy remains the primary life-sustaining treatment for patients with end-stage kidney disease. However, it is important to recognize how physically and psychologically demanding this treatment can be. The present article focuses particularly on patients undergoing hemodialysis, whose treatment involves numerous dietary restrictions, regular visits to dialysis centers, and frequent medical monitoring. These factors substantially affect daily functioning, influencing patients' physical activity levels, social life, and overall quality of life [11,12]. Due to both the disease itself and the restrictions associated with RRT, engaging in regular physical activity represents a significant challenge for individuals with CKD. Consequently, physical inactivity is highly prevalent among dialysis patients, despite growing evidence demonstrating the multiple benefits of exercise in individuals receiving renal replacement therapy. Importantly, the physical performance of these patients is closely linked not only to their physical health but also to their psychological well-being [13,14]. This article reviews various strategies aimed at increasing physical activity among patients undergoing dialysis, evaluates their potential clinical effectiveness, and discusses the prospects of incorporating exercise as an integral component of the management of end-stage kidney disease.

Table 1. Staging of CKD

CKD stadium	eGFR (ml/min/1.73 m <sup>2</sup> )
G1	≥90
G2	60-89
G3a	45-59
G3b	30-44
G4	15-29
G5	<15

### Pathophysiological Basis for Exercise in Hemodialysis Patients

A holistic approach to patients with chronic kidney disease extends beyond the assessment of laboratory parameters and the provision of dialysis aimed solely at removing uremic toxins from the body. It is equally important to consider patients' physical and psychological well-being, as well as their overall quality of life. Contemporary medicine increasingly emphasizes the role of rehabilitation and physical activity as supportive components of treatment, even in patients with advanced stages of disease, including those undergoing dialysis therapy [15,16]. In recent years, greater emphasis has been placed on a patient-centered approach that takes into account individual needs and priorities rather than focusing exclusively on laboratory-based indicators of health status. Increasing the level of physical activity - particularly among older patients - may help prevent sarcopenia and frailty, thereby reducing the risk of functional decline and loss of independence. Unfortunately, individuals requiring renal replacement therapy frequently avoid physical exertion and adopt a sedentary lifestyle, which contributes to insulin resistance, disturbances in lipid metabolism, atherosclerosis, and the exacerbation of systemic inflammation [17,18]. Patients with CKD often demonstrate limited willingness to engage in physical activity due to common comorbidities such as cardiovascular disease, reduced muscle strength, malnutrition, and impaired psychological well-being. It is important, however, to recognize the crucial role of skeletal muscle in maintaining human health. Beyond its primary mechanical function related to movement, skeletal muscle also performs numerous metabolic and regulatory roles within the body. A significant advancement in understanding these functions came with the discovery of myokines - small peptides and cytokines released by skeletal muscle in response to physical activity. These molecules participate in a variety of regulatory processes and facilitate communication between skeletal muscle and other organs, including the liver, adipose tissue, and kidneys. In patients with chronic kidney disease, disturbances in myokine production and signaling may contribute to the development of sarcopenia, chronic inflammation, and metabolic dysfunction, highlighting the potential importance of physical activity in modulating these processes [19-22]. Moreover, given that type 2 diabetes remains one of the leading causes of chronic kidney disease, strategies aimed at increasing skeletal muscle mass and metabolic activity - particularly regular physical exercise - may improve insulin sensitivity and glycemic control and potentially slow the progression of

diabetic nephropathy. In some patients, such interventions may reduce the likelihood of requiring renal replacement therapy in the future [23]. Physical activity also supports cardiovascular health, which is particularly relevant since cardiovascular complications represent one of the leading causes of mortality among patients with CKD [24]. Taken together, these mechanisms suggest that physical activity may constitute an important supportive element in the management of patients with chronic kidney disease undergoing dialysis therapy, contributing to improved physiological function and overall health outcomes.

## Types of Physical Activity in Hemodialysis Patients

Patients undergoing dialysis therapy are often characterized by low levels of physical activity, despite its important role in maintaining - and potentially improving - their overall health status and functional capacity. Several forms of exercise have been investigated in studies involving patients receiving dialysis. However, it should be emphasized that current recommendations in this area remain limited, and clear, standardized strategies for maintaining optimal levels of physical activity in dialysis patients have not yet been established [25]. Physical activity in this population can be broadly categorized according to its type into aerobic exercise and resistance training. It can also be classified based on the setting in which it is performed, including home-based exercise and training programs conducted within dialysis centers. The following sections describe in greater detail the forms of exercise most commonly implemented in patients undergoing dialysis therapy [26].

### **3. 1 Resistance Training in Hemodialysis Patients**

Loss of skeletal muscle mass is a well-documented factor associated with increased mortality among patients undergoing renal replacement therapy. Sarcopenia affects nearly 42.4% of individuals receiving hemodialysis, and both diabetes mellitus and prolonged duration of renal replacement therapy further increase the risk of its development. Consequently, resistance training appears to represent an important and beneficial form of physical activity in this patient population [27,28]. In one study, progressive resistance training was implemented during hemodialysis sessions. The exercises were specifically designed to be performed in a seated or semi-recumbent position, allowing them to be safely conducted during the dialysis procedure. Training sessions were performed three times per week, corresponding with each patient's visit to the dialysis center. Each session lasted approximately 45 minutes and included 10 exercises targeting the major muscle groups. The exercise program included movements such as shoulder press, biceps curl, triceps extension, hip flexion, seated leg curl, and seated leg lifts, performed with gradually increasing resistance, most commonly using dumbbells or ankle weights. The training program lasted either 12 or 24 weeks, and no complications related to resistance exercise were reported during the intervention [27]. Another study similarly confirmed the effectiveness of resistance training sessions lasting approximately 30 minutes during dialysis, highlighting their beneficial impact on overall physical performance, well-being, and several physiological parameters discussed in the subsequent sections of this review [29]. In addition, strategies based on home-based resistance training have also been investigated. Similar to exercise programs conducted in dialysis units, these protocols typically involve exercises performed with dumbbells or resistance bands two to three times per week for approximately 30 minutes per session. Although such interventions appear promising, monitoring adherence,

training quality, and exercise frequency is considerably more challenging when patients perform exercises independently at home compared with supervised programs conducted during dialysis sessions. As a result, evidence identifying the most effective and optimal home-based exercise strategies for dialysis patients remains limited [30-32].

### **3. 2 Aerobic Training in Dialysis Patients**

Another form of physical activity applied in patients undergoing dialysis is aerobic exercise. The most commonly used modalities in individuals receiving renal replacement therapy include walking and the use of a small stationary cycle ergometer [33]. In terms of frequency and duration, aerobic exercise sessions are generally comparable to resistance training programs. Based on studies conducted in dialysis centers, exercise sessions typically begin with a 5-minute warm-up consisting of light pedaling on a stationary cycle ergometer or active stretching. This is followed by the main training phase of moderate intensity (40-80% HRR - Heart Rate Reserve), lasting approximately 15-30 minutes, and concluding with a 5-minute cool-down period. Exercise sessions are usually performed during the first one to two hours of the dialysis procedure. Training programs typically last between 8 and 12 weeks, and similarly to resistance training interventions, no significant adverse events related to this form of physical activity have been reported during their implementation [34-36]. To date, it has not been definitively established which type of physical activity - aerobic or resistance training - provides the greatest benefit for patients undergoing hemodialysis. Ongoing research aims to better define and standardize exercise protocols, including aerobic, resistance, and combined training programs, for this patient population [37].

#### **Clinical Outcomes Associated with Physical Activity in Hemodialysis Patients**

Numerous studies indicate that regular physical activity in patients undergoing hemodialysis provides a wide range of clinical benefits, including improvements in physical performance as well as favorable changes in selected metabolic parameters. It is worth emphasizing that aerobic exercise performed during dialysis sessions may enhance cardiorespiratory fitness and overall physical capacity, while also contributing to a reduction in fatigue [38]. Exercise training has also been shown to improve muscle microcirculation by increasing blood flow within skeletal muscles and expanding the number of active capillaries. This process may facilitate the transport of metabolic waste products, such as urea, from tissues into the bloodstream, thereby enhancing their removal during dialysis [39]. Many studies have also reported improvements in functional performance tests. Following exercise interventions, a significant increase in the distance covered during the 6-minute walk test has been observed, indicating improved exercise tolerance [40]. At the same time, reductions in resting heart rate and blood pressure have been documented, along with increases in hemoglobin concentration and high-density lipoprotein (HDL) cholesterol levels. These physiological adaptations may contribute to improved cardiovascular function, which remains a key determinant of prognosis in patients with chronic kidney disease [41]. Furthermore, the Dialysis Training Therapy (DiaTT) study demonstrated that a supervised endurance and resistance training program conducted three times per week during dialysis sessions improved lower limb muscle strength, as assessed by the 60-second sit-to-stand test [42]. Physical activity may also positively influence the severity of symptoms commonly associated with dialysis therapy. Studies have shown that exercise performed on cycle ergometers during dialysis sessions can reduce fatigue, while aerobic training may alleviate symptoms such as muscle cramps and restless legs syndrome. Similar benefits have

also been reported in older hemodialysis patients, in whom physical training was associated with reduced pain, decreased fatigue, and improved overall physical functioning [43]. Regular physical activity also exerts important metabolic and anti-inflammatory effects. Exercise has been shown to reduce visceral adipose tissue and decrease the secretion of pro-inflammatory adipokines, thereby contributing to the modulation of inflammatory responses and improvement of the metabolic profile [44]. Some studies have also reported a potential influence of exercise training on bone metabolism, including improvements in bone mineral density and changes in markers of the bone-kidney axis, such as fibroblast growth factor 23 (FGF-23) [45]. Nevertheless, it should be emphasized that high-quality studies allowing for a definitive evaluation of specific training protocols and their associated health benefits in dialysis patients remain limited.

### Impact on Quality of Life and Psychological Well-Being

In a holistic approach to patient care, attention should be paid not only to physical well-being but also to quality of life and mental health. Modern medical care increasingly emphasizes outcomes beyond laboratory parameters, focusing on patients' ability to function independently, maintain social engagement, and preserve overall functional capacity. While the implementation of physical activity undoubtedly brings benefits for physical health, it is also important to recognize that regular exercise has a positive impact on psychological well-being and overall quality of life. Therapeutic strategies that incorporate physical activity as an integral component of treatment therefore aim not only to improve metabolic parameters and physical performance but also to support patients' mental well-being [46]. Studies conducted in recent years investigating the impact of physical activity on the quality of life of patients undergoing hemodialysis have demonstrated that the exercise programs described above may positively influence health-related quality of life (HRQoL) [47,48]. HRQoL refers to a patient's subjective perception of how their health status affects their overall quality of life and encompasses physical, psychological, emotional, and social dimensions of functioning related to health and disease. Instruments commonly used to assess HRQoL include standardized questionnaires such as the Short Form-36 (SF-36) and the EQ-5D [49]. Exercise programs implemented in patients with chronic kidney disease have been shown to produce beneficial effects on mental health regardless of the type of training performed - whether resistance or aerobic exercise - and regardless of whether the activity takes place during dialysis sessions or between them. The most favorable outcomes have been observed with moderate-intensity physical activity implemented in programs lasting between 12 and 26 weeks. In shorter interventions, improvements were primarily observed in the physical component of HRQoL, whereas longer training programs demonstrated beneficial effects on both the physical and psychological aspects of patients' lives [50,51]. In addition, evidence suggests that regular physical activity may contribute to the reduction of depressive symptoms in patients undergoing dialysis therapy [52,53]. A meta-analysis including 22 studies and 1,059 participants demonstrated a significant reduction in depressive symptoms among hemodialysis patients participating in exercise programs. The most pronounced benefits were observed in long-term interventions, often lasting longer than six months [53]. Based on the available evidence, incorporating physical activity into the standard management of patients undergoing dialysis appears justified, as improvements in quality of life are associated with lower mortality risk, fewer hospitalizations, and an overall reduction in health-related complications [54]. Nevertheless, it should be emphasized that currently available exercise programs are not fully standardized, and their parameters - such as exercise modality, intensity, and session duration - vary considerably

across studies. These differences may partly explain the inconsistencies observed in reported outcomes. Despite these limitations, many existing studies provide encouraging results demonstrating the beneficial impact of physical activity on quality of life and psychological well-being in this patient population, highlighting the need for further research and the development of more consistent and structured exercise strategies.

Table 1. Physical and psychological benefits of physical activity in patients undergoing hemodialysis

Physical Health Benefits	Mental Health Benefits
<ul style="list-style-type: none"> <li>● improved cardiorespiratory capacity and exercise tolerance</li> <li>● increased muscle strength and improved muscle function</li> <li>● improved cardiovascular function (including reductions in blood pressure and resting heart rate)</li> <li>● improved metabolic parameters (including increased HDL cholesterol and hemoglobin levels)</li> <li>● anti-inflammatory effects</li> <li>● reduction of dialysis-related symptoms (e.g., fatigue, muscle cramps, and restless legs syndrome)</li> </ul>	<ul style="list-style-type: none"> <li>● improved health-related quality of life (HRQoL)</li> <li>● improved psychological well-being and emotional functioning</li> <li>● reduction in depressive symptoms</li> <li>● improved social functioning and ability to perform activities of daily living</li> <li>● reduced fatigue affecting daily functioning</li> </ul>

Conclusions

End-stage kidney disease remains a significant clinical and social challenge, leading to substantial deterioration in patients’ health status, physical functioning, and overall quality of life. The need for regular hemodialysis imposes not only a considerable physiological burden but also substantial limitations in daily functioning, often resulting in partial loss of independence, reduced social engagement, and impaired psychological well-being. Although kidney transplantation represents the most effective treatment for end-stage kidney disease, it is not available to all patients; therefore, for many individuals dialysis therapy remains the only life-sustaining treatment option. Despite advances in pharmacological therapy and continuous specialist care, the quality of life of patients undergoing dialysis remains markedly reduced. Modern medicine increasingly emphasizes the importance of a comprehensive approach to the management of chronic diseases, in which collaboration within a multidisciplinary team of specialists plays a crucial role. Within this context, growing attention has been directed toward

the role of physical activity as a supportive therapeutic strategy in patients with chronic kidney disease. This review presents available evidence on various forms of physical activity implemented in hemodialysis patients and their potential benefits for both physical and psychological health. The available data suggest that regular physical activity may contribute to improvements in physical performance, muscle strength, cardiovascular function, and metabolic parameters. At the same time, exercise interventions appear to positively influence health-related quality of life, reduce fatigue, and alleviate depressive symptoms in patients undergoing dialysis therapy. However, despite the increasing number of studies demonstrating the potential benefits of exercise, high-quality clinical trials enabling the development of fully standardized training programs for this patient population remain limited. Differences in exercise modality, intensity, duration of training sessions, and methods of monitoring may partly explain the variability observed in reported outcomes across studies. Therefore, further large-scale clinical studies are required to determine the optimal parameters of exercise programs and to evaluate their long-term effects on health outcomes in dialysis patients. In light of current evidence, incorporating physical activity as a routine component of care for patients undergoing dialysis in dialysis centers appears justified. Improvements in physical fitness and quality of life may potentially contribute to reduced hospitalization rates and lower mortality risk in this population. In the future, the development of personalized medicine may facilitate the design of exercise programs tailored not only to patients' medical needs and physical capabilities but also to their individual preferences, which could enhance adherence to physical activity and improve the long-term effectiveness of such interventions. Emerging technologies, including telemedicine, remote monitoring of physical activity, and solutions based on artificial intelligence, may further support the implementation of exercise programs in home settings while allowing supervision by qualified healthcare professionals. Nevertheless, the implementation of such approaches requires appropriate financial resources and the availability of trained personnel capable of ensuring the safety and quality of exercise interventions. In summary, physical activity represents a promising adjunct in the management of patients with chronic kidney disease undergoing hemodialysis. Although further research is needed to establish unified exercise recommendations for this population, current scientific evidence indicates that appropriately designed and supervised physical activity may significantly improve health status, functional capacity, and quality of life in dialysis patients.

## **Disclosure**

### **Author's Contribution**

Conceptualization: Tomasz Wołoszczuk, Zofia Graca, Maciej Łabuś, Elżbieta Siudmak, Aleksandra Skowronek, Jakub Kołodziej, Julia Jeziorna, Adam Iwanicki, Agnieszka Sawina, Aleksandra Skawińska

Methodology: Tomasz Wołoszczuk, Zofia Graca, Aleksandra Skowronek, Elżbieta Siudmak

Formal analysis: Julia Jeziorna, Aleksandra Skawińska, Maciej Łabuś, Adam Iwanicki, Agnieszka Sawina

Investigation: Tomasz Wołoszczuk, Aleksandra Skowronek, Agnieszka Sawina

Supervision: Zofia Graca, Elżbieta Siudmak, Julia Jeziorna, Adam Iwanicki

Writing rough preparation: Aleksandra Skawińska, Maciej Łabuś, Jakub Kołodziej

Writing review and editing: Zofia Graca, Tomasz Wołoszczuk

Receiving funding: Not applicable

All authors have read and agreed with the published version of the manuscript.

**Funding**

The article did not receive any funding.

**Institutional Review and Board Statement**

Not applicable.

**Informed Consent Statement**

Not applicable.

**Data Availability Statement**

Not applicable.

**Conflict of Interest Statement**

Authors declare no conflicts of interest.

**AI**

AI-assisted language editing was used during the preparation of this manuscript. ChatGPT (OpenAI) was used to support grammar correction and refinement of scientific language. The authors reviewed, edited, and approved the final version of the text and take full responsibility for the content of the manuscript.

**References**

1. Couchoud C, Bouzille G, Piveteau J, Lassalle M, Lazareth H, Hamroun A, et al. The steps of constructing and validating an algorithm to identify chronic kidney disease patients in medical administrative databases. *J Epidemiol Popul Health.* 2026;74(2):203370. <https://doi.org/10.1016/j.jep.2026.203370>
2. Drabczyk N. Przewlekła niewydolność nerek [Internet]. *Medycyna Praktyczna*; [cited 2026 Mar 12]. Available from: <https://www.mp.pl/pacjent/nefrologia/choroby/chorobyudoroslych/51919,przewlekla-niewydolnosc-nerek>
3. Rafferty Q, Stafford LK, Vos T, Thomé FS, Aalruz H, Abate YH, et al. Global, regional, and national prevalence of kidney failure with replacement therapy and associated aetiologies, 1990-2023: a systematic analysis for the Global Burden of Disease Study 2023. *Lancet Glob Health.* 2025;13(8):e1378-e1395. [https://doi.org/10.1016/S2214-109X\(25\)00198-6](https://doi.org/10.1016/S2214-109X(25)00198-6)
4. National Health Service. Chronic kidney disease [Internet]. NHS; 2025 [cited 2026 Mar 12]. Available from: <https://www.nhs.uk/conditions/kidney-disease/>
5. Drawz P, Rahman M. Chronic kidney disease. *Ann Intern Med.* 2015;162(11):ITC1-ITC16. <https://doi.org/10.7326/AITC201506020>

6. Chen TK, Knicely DH, Grams ME. Chronic kidney disease diagnosis and management. *JAMA*. 2019;322(13):1294-1304. <https://doi.org/10.1001/jama.2019.14745>
7. National Kidney Foundation. Kidney failure [Internet]. National Kidney Foundation; [cited 2026 Mar 12]. Available from: <https://www.kidney.org/kidney-topics/kidney-failure>
8. Grinyó JM. Why is organ transplantation clinically important? *Cold Spring Harb Perspect Med*. 2013;3(6):a014985. <https://doi.org/10.1101/cshperspect.a014985>
9. Tonelli M, Wiebe N, Knoll G, Bello A, Browne S, Jadhav D, et al. Systematic review: kidney transplantation compared with dialysis in clinically relevant outcomes. *Am J Transplant*. 2011;11(10):2093-2109. <https://doi.org/10.1111/j.1600-6143.2011.03686.x>
10. Flythe JE, Watnick S. Dialysis for chronic kidney failure. *JAMA*. 2024;332(18):1559-1560. <https://doi.org/10.1001/jama.2024.16338>
11. Hanspal I, Fathima F, Kedlaya P. Social impact of end-stage renal disease requiring hemodialysis among patients with type 2 diabetes and their caregivers in Bengaluru, Karnataka. *Indian J Community Med*. 2021;46(4):626-630. [https://doi.org/10.4103/ijcm.ijcm\\_995\\_20](https://doi.org/10.4103/ijcm.ijcm_995_20)
12. Tzanetakou IP, et al. Social life of patients undergoing haemodialysis. *Int J Caring Sci*. 2016;9(1):122-134. Available from: [https://www.researchgate.net/publication/301200809\\_Social\\_Life\\_of\\_Patients\\_Undergoing\\_Haemodialysis](https://www.researchgate.net/publication/301200809_Social_Life_of_Patients_Undergoing_Haemodialysis)
13. Wang AY, Sherrington C, Toyama T, Gallagher MP, Cass A, Hirakawa Y, et al. Muscle strength, mobility, quality of life and falls in patients on maintenance haemodialysis: a prospective study. *Nephrology (Carlton)*. 2017;22(3):220-227. <https://doi.org/10.1111/nep.12749>
14. Painter P, Marcus RL. Assessing physical function and physical activity in patients with CKD. *Clin J Am Soc Nephrol*. 2013;8(5):861-872. <https://doi.org/10.2215/CJN.06590712>
15. Kalantar-Zadeh K, Wightman A, Liao S. Ensuring choice for people with kidney failure-dialysis, supportive care, and hope. *N Engl J Med*. 2020;383(2):99-101. <https://doi.org/10.1056/NEJMp2001794>
16. Wilkinson TJ, McAdams-DeMarco M, Bennett PN, Wilund K. Advances in exercise therapy in predialysis chronic kidney disease, hemodialysis, peritoneal dialysis, and kidney transplantation. *Curr Opin Nephrol Hypertens*. 2020;29(5):471-479. <https://doi.org/10.1097/MNH.0000000000000627>
17. Deligiannis A, D'Alessandro C, Cupisti A. Exercise training in dialysis patients: impact on cardiovascular and skeletal muscle health. *Clin Kidney J*. 2021;14(Suppl 2):ii25-ii33. <https://doi.org/10.1093/ckj/sfaa273>

18. Park JH, Moon JH, Kim HJ, Kong MH, Oh YH. Sedentary lifestyle: overview of updated evidence of potential health risks. *Korean J Fam Med.* 2020;41(6):365-373. <https://doi.org/10.4082/kjfm.20.0165>
19. Leuchtmann AB, Adak V, Dilbaz S, Handschin C. The role of the skeletal muscle secretome in mediating endurance and resistance training adaptations. *Front Physiol.* 2021;12:709807. <https://doi.org/10.3389/fphys.2021.709807>
20. Pourteymour S, Eckardt K, Holen T, Langleite T, Lee S, Jensen J, et al. Global mRNA sequencing of human skeletal muscle: search for novel exercise-regulated myokines. *Mol Metab.* 2017;6(4):352-365. <https://doi.org/10.1016/j.molmet.2017.01.007>
21. Kirk B, Feehan J, Lombardi G, Duque G. Muscle, bone, and fat crosstalk: the biological role of myokines, osteokines, and adipokines. *Curr Osteoporos Rep.* 2020;18(4):388-400. <https://doi.org/10.1007/s11914-020-00599-y>
22. Leal LG, Lopes MA, Batista ML. Physical exercise-induced myokines and muscle-adipose tissue crosstalk: a review of current knowledge and the implications for health and metabolic diseases. *Front Physiol.* 2018;9:1307. <https://doi.org/10.3389/fphys.2018.01307>
23. Xu Y, Hu T, Shen Y, Wang Y, Bao Y, Ma X. Association of skeletal muscle mass and its change with diabetes occurrence: a population-based cohort study. *Diabetol Metab Syndr.* 2023;15(1):53. <https://doi.org/10.1186/s13098-023-01027-8>
24. Gansevoort RT, Correa-Rotter R, Hemmelgarn BR, Jafar TH, Heerspink HJL, Mann JF, et al. Chronic kidney disease and cardiovascular risk: epidemiology, mechanisms, and prevention. *Lancet.* 2013;382(9889):339-352. [https://doi.org/10.1016/S0140-6736\(13\)60595-4](https://doi.org/10.1016/S0140-6736(13)60595-4)
25. Bennett PN, Breugelmans L, Barnard R, Agius M, Chan D, Fraser D, et al. Sustaining a hemodialysis exercise program: a review. *Semin Dial.* 2010;23(1):62-73. <https://doi.org/10.1111/j.1525-139X.2009.00652.x>
26. John SG, Sigrist MK, Taal MW, McIntyre CW. Natural history of skeletal muscle mass changes in chronic kidney disease stage 4 and 5 patients: an observational study. *PLoS One.* 2013;8(5):e65372. <https://doi.org/10.1371/journal.pone.0065372>
27. Cheema BSB, O'Sullivan AJ, Chan M, Patwardhan A, Kelly J, Gillin A, et al. Progressive resistance training during hemodialysis: rationale and method of a randomized controlled trial. *Hemodial Int.* 2006;10(3):303-310. <https://doi.org/10.1111/j.1542-4758.2006.00112.x>
28. Othman RB, Balti A, Boukhris S, Ceylan HI, Jamoussi H, Muntean RI, et al. Sarcopenia in hemodialysis patients: prevalence, independent risk factors, and functional implications-A

- multicenter cross-sectional study. *J Clin Med.* 2025;14(19):6893. <https://doi.org/10.3390/jcm14196893>
29. Chung Y, Yeh M, Liu Y. Effects of intradialytic exercise on the physical function, depression and quality of life for haemodialysis patients: a systematic review and meta-analysis of randomized controlled trials. *J Clin Nurs.* 2017;26(13-14):1801-1813. <https://doi.org/10.1111/jocn.13514>
30. Lee CL, Wang PC, Chen YL, Chen ZY, Uen CC, Lai HY, et al. Comparisons of intradialytic exercise versus home-based exercise in hemodialysis patients: a narrative review. *Biomedicines.* 2024;12(10):2364. <https://doi.org/10.3390/biomedicines12102364>
31. De Araújo TB, De Luca Corrêa H, De Deus LA, Neves RVP, Reis AL, Honorato FS, et al. The effects of home-based progressive resistance training in chronic kidney disease patients. *Exp Gerontol.* 2023;171:112030. <https://doi.org/10.1016/j.exger.2022.112030>
32. Halle M, Manfredini F, Floege J, Zoccali C. Physical exercise in haemodialysis patients: which type of exercise is more convenient? *Clin Kidney J.* 2024;17(7):sfae165. <https://doi.org/10.1093/ckj/sfae165>
33. Ferrari F, Andrade FP, Teixeira MS, Ziegelmann PK, Carvalho G, Bittencourt ESS, et al. Efficacy of six exercise-based interventions for individuals undergoing hemodialysis: a network meta-analysis of randomized clinical trials. *Nephrol Dial Transplant.* 2023;38(10):2389-2406. <https://doi.org/10.1093/ndt/gfad083>
34. Jung TD, Park SH. Intradialytic exercise programs for hemodialysis patients. *Chonnam Med J.* 2011;47(2):61-65. <https://doi.org/10.4068/cmj.2011.47.2.61>
35. Mohseni R, Zeydi AE, Ilali E, Adib-Hajbaghery M, Makhloogh A. The effect of intradialytic aerobic exercise on dialysis efficacy in hemodialysis patients: a randomized controlled trial. *Oman Med J.* 2013;28(5):345-349. <https://doi.org/10.5001/omj.2013.99>
36. Wahida AZ, Rumahorbo H, Murtiningsih. The effectiveness of intradialytic exercise in ameliorating fatigue symptoms in patients with chronic kidney failure undergoing hemodialysis: a systematic literature review and meta-analysis. *J Taibah Univ Med Sci.* 2023;18(3):512-525. <https://doi.org/10.1016/j.jtumed.2022.11.004>
37. Nakoui N, Ilbeigi S, Ahmadi MM, Saber A. Comparison of the effect of aerobic and resistance training on fatigue, quality of life and biochemical factors in hemodialysis patients. *Sci Rep.* 2025;15(1):10052. <https://doi.org/10.1038/s41598-025-94257-x>
38. Raj VSV, Mangalvedhe PV, Shetty MS, Balakrishnan DC. Impact of exercise on fatigue in patients undergoing dialysis in a tertiary care hospital. *Cureus.* 2023;15(2):e35004. <https://doi.org/10.7759/cureus.35004>

39. Kong CH, Tattersall JE, Greenwood RN, Farrington K. The effect of exercise during haemodialysis on solute removal. *Nephrol Dial Transplant.* 1999;14(12):2927-2931. <https://doi.org/10.1093/ndt/14.12.2927>
40. Segura-Ortí E, Kouidi E, Lisón JF. Effect of resistance exercise during hemodialysis on physical function and quality of life: randomized controlled trial. *Clin Nephrol.* 2009;71(5):527-537. <https://doi.org/10.5414/cnp71527>
41. De Moura Reboredo M, Henrique DMN, De Souza Faria R, Chaoubah A, Bastos MG, De Paula RB. Exercise training during hemodialysis reduces blood pressure and increases physical functioning and quality of life. *Artif Organs.* 2010;34(7):586-593. <https://doi.org/10.1111/j.1525-1594.2009.00929.x>
42. Von Gersdorff G, Von Korn P, Duvinage A, Ihorst G, Josef A, Kaufmann M, et al. Cluster randomized controlled trial on the effects of 12 months of combined exercise training during hemodialysis in patients with chronic kidney disease-study protocol of the Dialysis Training Therapy (DiaTT) trial. *Methods Protoc.* 2021;4(3):60. <https://doi.org/10.3390/mps4030060>
43. Hargrove N, Tobgy NE, Zhou O, Pinder M, Plant B, Askin N, et al. Effect of aerobic exercise on dialysis-related symptoms in individuals undergoing maintenance hemodialysis. *Clin J Am Soc Nephrol.* 2021;16(4):560-574. <https://doi.org/10.2215/CJN.15080920>
44. Flynn MG, McFarlin BK, Markofski MM. The anti-inflammatory actions of exercise training. *Am J Lifestyle Med.* 2007;1(3):220-235. <https://doi.org/10.1177/1559827607300283>
45. Fakhrpour R, Hamid TK, Ebrahim K. Effect of sixteen weeks combined training on FGF-23, Klotho, and Fetuin-A levels in patients on maintenance hemodialysis. *Iran J Kidney Dis.* 2020;14(3):212-218.
46. Mahindru A, Patil P, Agrawal V. Role of physical activity on mental health and well-being: a review. *Cureus.* 2023;15(1):e33475. <https://doi.org/10.7759/cureus.33475>
47. Tsai YC, Chen HM, Hsiao SM, Chen CS, Lin MY, Chiu YW, et al. Association of physical activity with cardiovascular and renal outcomes and quality of life in chronic kidney disease. *PLoS One.* 2017;12(8):e0183642. <https://doi.org/10.1371/journal.pone.0183642>
48. Martins P, Marques EA, Leal DV, Ferreira A, Wilund KR, Viana JL. Association between physical activity and mortality in end-stage kidney disease: a systematic review of observational studies. *BMC Nephrol.* 2021;22(1):227. <https://doi.org/10.1186/s12882-021-02407-w>
49. LEKsykon. HRQoL - health-related quality of life [Internet]. Available from: <https://leksykon.com.pl/tag/hrqol/>

50. Hu H, Liu X, Chau PH, Choi EPH. Effects of intradialytic exercise on health-related quality of life in patients undergoing maintenance haemodialysis: a systematic review and meta-analysis. *Qual Life Res.* 2022;31(7):1915-1932. <https://doi.org/10.1007/s11136-021-03025-7>
51. Yuenyongchaiwat K, Namdang P, Vasinsarunkul P, Phongsukree P, Chaturattanachaiyaporn K, Pairojkittrakul S, et al. Effectiveness of inspiratory muscle training on respiratory fitness and breathlessness in chronic renal failure: a randomized controlled trial. *Physiother Res Int.* 2021;26(1):e1879. <https://doi.org/10.1002/pri.1879>
52. Ouzouni S, Kouidi E, Sioulis A, Grekas D, Deligiannis A. Effects of intradialytic exercise training on health-related quality of life indices in haemodialysis patients. *Clin Rehabil.* 2009;23(1):53-63. <https://doi.org/10.1177/0269215508096760>
53. Yu H, Huang M, Tao Y, Li S, Wang J, Li P, et al. The effects of exercise training interventions on depression in hemodialysis patients. *Front Psychiatry.* 2024;14:1321413. <https://doi.org/10.3389/fpsy.2023.1321413>
54. Lowrie EG, Curtin RB, LePain N, Schatell D. Medical outcomes study short form-36: a consistent and powerful predictor of morbidity and mortality in dialysis patients. *Am J Kidney Dis.* 2003;41(6):1286-1292. [https://doi.org/10.1016/S0272-6386\(03\)00361-5](https://doi.org/10.1016/S0272-6386(03)00361-5)