



## **EFFECTS OF AEROBIC EXERCISE ON PHYSICAL CONDITION IN CHRONIC KIDNEY DISEASE PATIENTS: SCOPING REVIEW**

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### **ABSTRACT**

Chronic kidney disease (CKD) can cause changes in physical condition and cause cardiovascular problems to death. The development of CKD can be prevented by doing physical activity, one of which is aerobic exercise. Studies related to the effects of aerobic exercise on physical condition, especially in patients with chronic kidney disease, are still limited, so further studies are needed. The purpose of this study was to determine the effect of aerobic exercise on physical condition in patients with chronic kidney disease. The method used is a scoping review based on the PRISMA flow diagram. Article searches were conducted using electronic databases or internet searches, some databases used as article selection are ScienceDirect, Pubmed, and Springerlink. In conducting the search using the keywords "Aerobic Exercise" and "Chronic Kidney Disease" and "physical condition". Where in the screening or filtering of articles are given the filters "2020-2024", "Free full text" and "research article". The scoping review analysis was carried out using the Arksey and O'Malley theory approach which has been modified by Levac. From 4 databases, 6 articles were analyzed and focused on the effect of aerobic exercise on physical conditions in patients with chronic kidney disease. The results of the analysis showed that aerobic exercise significantly increased the SPPB (Short physical performance battery) value, increased the HRV (heart rate variability) index within the normal range, increased vagal activity leading to sympathovagal balance, improved systolic and diastolic values, increased physical activity levels, and decreased blood glucose and increased hematocrit. The effect of Aerobic exercise on the physical condition of patients is divided into physiological and biochemical effects. The effect of Aerobic exercise on physical conditions physiologically is to improve physical function, functional capacity and activity of the autonomic nervous system of the heart, increase blood flow, reduce risk factors for cardiovascular disease, increase cardiorespiratory capacity and muscle strength of the upper and lower body, and have a more comprehensive range in activities. The effect of Aerobic exercise on physical conditions biochemically is to maintain stable blood levels.

Keywords: aerobic exercise; chronic kidney disease; effects; physical condition

### **How to cite (in APA style)**

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## **INTRODUCTION**

Chronic kidney disease (CKD) is a problem that affects the kidneys, causing them to lose function and unable to maintain body fluid composition and volume. (Baradero M & Daydrit MW, 2009) CKD lasts to several years and progressive or continues to develop and irreversible or cannot return to the original form and the previous function. CKD patients require specialized therapy in the form of hemodialysis (HD) to support kidney function to filter blood (Price, 2006) The results of the Basic Health Research (RISKESDAS) of the Republic of Indonesia in 2018 showed data on respondents who had a diagnosis of CKD of around 10 million people or around 3.8%. Central Java was recorded as the 4th highest province in Java after West Java, DKI and DIY with CKD patients totaling 1.3 million people or around 4%. (Kemenkes RI, 2018) Data from PERNEFRI (Indonesian Nephrology Society) in 2016 in Indonesia showed that patients undergoing HD therapy reached 52,835 people. (Registry, 2016) PERNEFRI data in 2017 showed an increase in the number of patients undergoing HD therapy to 77,892 people. (Registry, 2017) Central Java Province is one of the provinces that has experienced an increase in the number of CKD patients who perform HD

therapy. According to PERNEFRI data in 2016, there were 4,869 people in Central Java undergoing HD therapy (Registry, 2016). In 2017, the number of patients on HD therapy increased to 6,828 patients. (Registry, 2017)

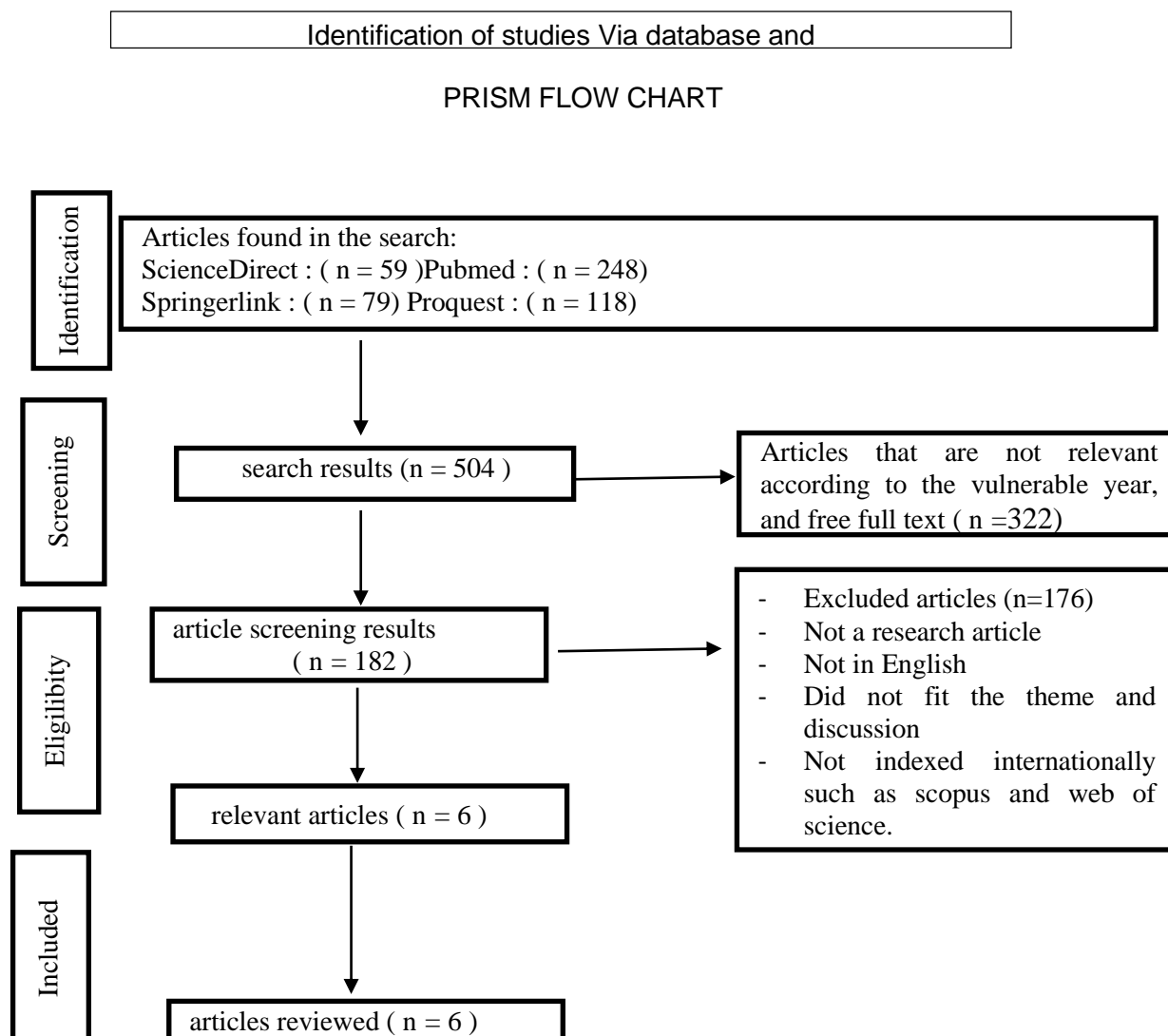
Chronic kidney disease (CKD) is a disease that is progressive and easily progresses to the final stage and can cause cardiovascular problems and death. (Muttakin, 2011) The progression of CKD can be prevented by doing physical activity to improve muscle strength, cardiorespiratory endurance, and quality of life. Frequently experienced problems felt by CKD, patients need proper management to avoid a decrease in the quality of life of CKD patients. One alternative is providing physical exercise to improve physical conditions in CKD patients. Physical exercise aims to improve and maintain aspects of physical fitness, maintain and improve overall body health. (Firdaus et al., 2022) Aerobic exercise is an exercise to maintain body function with the addition of energy utilization that focuses on the use of muscles to form energy (Kurniawati et al, 2022). Aerobic exercise increases oxidative enzymes in the muscles, and by increasing the density of capillary supply mitochondria in the muscles, it can increase energy and reduce fatigue in CKD patients undergoing HD. (Prastiwi et al., 2021) Grigorou's research (2021) shows that intradialytic exercise using a mini bike 2x a week for 1 month can reduce fatigue scores in CKD patients. (Grigoriou et al., 2021) Yu's research (2021) shows that aerobic exercise can reduce cognitive decline in elderly patients with mild to moderate dementia. (Yu et al., 2021) Yao's research (2021) shows that aerobic exercise can improve mental health in elderly patients aged 60 years and over (Yao et al., 2021). The worsening physical condition of patients with chronic kidney disease requires further study so that it does not cause cardiovascular problems and even death. Studies related to the effects of aerobic exercise on physical conditions in patients with chronic kidney disease are currently limited, so it is necessary to conduct a more in-depth literature study. The purpose of this review is to determine the effect of aerobic exercise on physical condition in chronic kidney disease patients.

## **METHOD**

This review uses a scoping review approach. The scoping review research design was chosen because the reference sources that researchers use are varied and come from several articles from reputable journals. Scoping review is a method used to identify literature in depth and thoroughly from various sources with various research methods and has a relationship with the research topic. The stages in compiling a scoping review refer to Arksey & O'Malley (2005) which has been modified by Levac (2010) including identifying research questions clearly and objectively; identifying relevant articles; selection of related literature from articles and data extraction; organizing, summarizing, and analyzing; reporting data results (Arksey & O'Malley, 2005) (Danielle Levac & O'Brien, 2010) The research question is "What is the effect of aerobic exercise on physical condition in chronic kidney disease patients?" In mapping articles, data is filtered by the author using specific criteria or inclusion and exclusion. In this article, the intended criteria are articles published in the period 2020-2024, articles about aerobic exercise in chronic kidney disease patients, articles published in full can be accessed, articles published in English, quantitative articles and in accordance with the specified variables. Article searches are carried out using electronic databases or internet searches, some databases that are used as article selection are: 1. ScienceDirect, 2. Pubmed, 3. Springerlink, 4. Proquest. In searching using keywords or keywords "Aerobic Exercise" and "Chronic Kidney Disease" and "Physical Condition". Where in screening or filtering articles given filters "2020-2024", "Free full text", and "Research article".

The next step is the selection of each article, at this stage the literature or articles obtained from the electronic database of internationally indexed journals such as Scopus and Web of

Science from various inclusion criteria and keywords, the total number of searches obtained from 4 databases as much as :



## RESULT

The following table is a summary analysis of 10 articles that focus on the effect of aerobic exercise on physical condition in chronic kidney disease patients (Perez-Dominguez et al, 2021), (Mitsiou et al, 2022), (de Oliveira et al, 2020), ((Ortega-Pérez de Villar et al. 2020), (Yuguero-Ortiz et al, 2021), (Yamaguchi et al, 2023).

Table 1.  
Article Analysis

Writer	Year	Title	Objective	Design study	Sample	Results
Borja Perez-Dominguez , Jose Casaña-Granell , Rafael Garcia- Maset , Alicia Garcia-testal , Erika Melendez-Oliva , Eva Segura-Orti	2021	Effects of exercise programs on physical function and activity levels in patients undergoing hemodialysis: a randomized controlled trial	The aim of this study was to compare several exercise programs on hemodialysis patients' functional capacity and health-related quality of life.	The method in this study is a randomized controlled trial.	The sample in this study was 71 end-stage chronic kidney disease patients who undergoing hemodialysis for at least 3 months and had a stable	There was significant improvement in the SPPB (Short physical performance battery), a combination of physical tests assessing balance, walking speed, and lower limb functional strength and walking speed as assessments, so both groups had

Writer	Year	Title	Objective	Design study	Sample	Results
					medical condition.	improved physical function at the end of 16 weeks after aerobic exercise.
Maria Mitsiou , Eleftherios Dimitros, Stefanos Roumeliotis, Vassilios Liakopoulos and Asterios Deligiannis	2022	Effects of a Combined Intradialytic Exercise Training Program and Music on Cardiac Autonomic Nervous System Activity in Hemodialysis Patients	The purpose of this study was to determine the effect of intradialytic exercise program in combination with music on heart rate variability (HRV) index and functional capacity in hemodialysis patients	The method used in this study was a randomized controlled trial.	The samples in this study were 40 chronic kidney disease patients undergoing hemodialysis.	aerobic exercise combined with music can improve functional capacity and cardiac autonomic nervous system activity in hemodialysis patients.
Fabiano Santana de Oliveira, Mauro José de Deus Moraes, Luiz Carlos de Abreu, Andrés Ricardo Pérez-Riera, Vitor E Valenti, Laércio da Silva Paiva, Rodrigo Daminello Raimundo	2020	The effects of aerobic exercise on biochemical parameters in individuals with CKD on hemodialysis: A longitudinal study.	The purpose of this study was to analyze changes in biochemical parameters of subjects with chronic kidney disease who undergo exercise during hemodialysis.	The method used in this research is experimental study.	The samples in this study were 54 chronic kidney disease patients undergoing hemodialysis who were divided into intervention and control groups.	Aerobic exercise during hemodialysis is able to maintain stable blood levels and increase blood flow in chronic kidney disease patients both during hemodialysis and at the end of the session.
Lucía ortega-pérez de Villar, francisco José Martínez- olmos , francisco de Borja pérez - Domínguez, Vicent Benavent -caballer, francisco Javier Montañez- Aguilera, tom Mercer & eva Segura- ortí	2020	Comparison of intradialytic versus home-based exercise programs on physical functioning, physical activity level, adherence, and health-related quality of life: pilot study	The aim of this study is to compare the effect of 16 weeks Intradialytic Exercise with home based exercise program for HD patients.	The method used in this study is a randomized controlled trial	The participants in this study were 46 chronic kidney disease patients undergoing hemodialysis.	The combination of aerobic and resistance training can be considered as a potent stimulus to induce aerobic capacity adaptation and reduce cardiovascular disease risk factors in chronic kidney disease patients.
Anna Yuguero-Ortiza , Miquel Gomeza , Marta Arias- Guillena , Raquel Ojedaa , Néstor Fontseréa , Lida Rodasa , José Jesús Brosetaa , Manel Veraa , Sonsoles Hernandez- Sanchezb , Francisco Maduell	2021	Impact and safety outcomes of an intradialytic physical exercise program	The aim of this study was to evaluate the effect and safety of intradialytic exercise performed by a multidisciplinary team (physiotherapists and nurses).	The method used in this study was a quasi-experimental pre-post single-center prospective study.	The participants in this study were 34 chronic kidney disease patients undergoing hemodialysis.	aerobic exercise can improve cardiorespiratory capacity and upper and lower body muscle strength in HD patients.
Tomoya Yamaguchi , Hiroki Yabe, Kenichi Kono, Yoshifumi	2023	Differences in the purpose of exercise between hemodialysis	The purpose of this study was to evaluate exercise variation between individuals who	The method used in this study was multicenter retrospective	The participants in this study were 541 chronic	Participants who continued the exercise program had a more comprehensive range

Writer	Year	Title	Objective	Design study	Sample	Results
Moriyama, Tetsuya Yamada		patients who continued or dropped out of exercise programs: a multicenter cohort study	continued and engaged in the study and those who dropped out of the intradialytic exercise program. intradialytic exercise program in patients undergoing hemodialysis.	cohort study	kidney disease patients undergoing hemodialysis.	of activities, while the dropout group had lower physical function and was less proactive than the group that continued the exercise program.

The results synthesis of the articles analyzed regarding the effect of aerobic exercise on physical condition in chronic kidney disease patients is as follows:

1. Aerobic exercise significantly improved SPPB (Short physical performance battery) scores in the form of a combination of physical tests assessing balance, walking speed, and lower limb functional strength and walking speed as assessments, so that both groups experienced improved physical function at the end of 16 weeks after exercise.
2. Aerobic exercise combined with music can improve functional capacity and cardiac autonomic nervous system activity in hemodialysis patients. After 6 months of aerobic exercise program, the time and frequency domain HRV (heart rate variability) index increased within the normal range, indicating increased vagal activity leading to sympathovagal balance.
3. Aerobic exercise during hemodialysis is able to maintain stable blood levels and increase blood flow in chronic kidney disease patients both during hemodialysis and at the end of the session. In the intervention group, there was an improvement in systole and diastole values in participants after 3 months of aerobic exercise program. The average heart rate of participants in the intervention group of 105 bpm was defined as a safe value and was considered to have improved so that the patient's physical condition improved at the end of the program.
4. Aerobic exercise can be considered as a powerful stimulus to induce adaptation of aerobic capacity and reduce risk factors for cardiovascular disease in chronic kidney disease patients. The results of intradialytic exercise and home-based exercise groups have similar effectiveness in increasing the physical activity level of participants.
5. Aerobic exercise can improve cardiorespiratory capacity of the upper and lower body muscle strength in HD patients. The results of the study in the intervention group showed that cardiorespiratory capacity increased significantly with an average increase of 47 m in the 6 Minutes Walking Test (6MWT). Hand grip (HG) muscle strength in the intervention group increased with an average increase in muscle mass of 1.6 kg. Serum glucose levels in participants decreased while hematocrit values increased by 2%.
6. Participants who continued the aerobic exercise program had a more comprehensive range in daily life and activities, while the dropout group had lower physical function and was less proactive than the group that continued the exercise program.

## DISCUSSION

Analysis using the scoping review method found that aerobic exercise has a positive effect or influence on physical conditions in patients with chronic kidney disease. The results of the analysis consisted of 6 articles (Perez-Dominguez et al., 2021), (Mitsiou et al, 2022), (de Oliveira et al., 2020), (Ortega-Pérez de Villar et al., 2020), (Yuguero-Ortiz et al., 2021), (Yamaguchi et al., 2023) Aerobic exercise can improve physical function, functional capacity and autonomic nervous system activity, cardiac autonomic nervous system activity, maintain stable blood levels, increase blood flow, reduce risk factors for cardiovascular disease,

improve cardiorespiratory capacity and muscle strength of the upper and lower body, and have a more comprehensive range of activities.

### **Effects of Aerobic Exercise on physiological physical condition**

Aerobic exercise significantly improves SPPB (Short physical performance battery) scores in the form of a combination of physical tests that assess balance, walking speed, and lower limb functional strength and walking speed. This is in line with the research of Monti et al (2023) Aerobic exercise can improve physical performance as measured by SPPB (Short physical performance battery) and significantly improved for balance and chair stand. (Monti et al., 2023) Exercise has been shown to be beneficial in increasing the vasomotor reactivity of the brachial artery in patients, this is what causes increased endurance and walking distance in patients after doing aerobic exercise. (Billinger et al., 2012) Intradialytic exercise according to Rosaulina (2021) is a planned and organized form of physical activity, which aims to improve or maintain various elements of physical fitness. (Rosaulina & Gurusinga, 2021) Intradialytic exercise consists of 3 types, namely flexibility exercise, resistance exercise, and aerobic exercise. (Wahida, Rumahorbo, & Murtiningsih, 2023) Aerobic exercise combined with music can improve functional capacity and activity of the cardiac autonomic nervous system. (Mitsiou et al., 2022) This is in line with Pinge's research (2011) Aerobic exercise provides an effect in the form of improved cardiac circulation and skeletal muscle, improved cardiac autonomic control, and reduced intensity of bradycardia. (Martins-Pinge, 2011) Exercise participants show an increase in maximal oxygen uptake, which is accompanied by several cardiovascular adaptations such as rapid ventricular filling and increased myocardial contractility with larger stroke volume, and increased capillary supply. All these effects favor high oxygen extraction by the muscles used for exercise. These cardiac and skeletal muscle adaptations help maintain cardiac output with less energy expenditure accompanied by a lower heart rate that does not spike too high (Martins-Pinge, 2011).

Aerobic exercise is effective to induce adaptation of aerobic capacity and reduce risk factors for cardiovascular disease in chronic kidney disease patients. This is in line with research by Bronas (2009) that there is a mechanism of blood pressure reduction due to aerobic exercise. This is thought to be due to several factors including improved vascular endothelial function and arterial compliance, increased baroreceptor sensitivity reflex, and decreased circulating catecholamines. These cardiovascular disease risk factors are reduced due to the response obtained after aerobic exercise training, which can improve survival in CKD patients. (Afsar et al., 2018) In addition, aerobic exercise improves aerobic capacity, muscle strength and endurance, and quality of life. (Bronas, 2009). Aerobic exercise can improve cardiorespiratory capacity and upper and lower body muscle strength in HD patients. This is in line with the research of De Lima et al (2013) that functional performance and respiratory muscle strength evaluated by NSA (step test) and manovacuometry (MIP), respectively, showed a statistically significant increase in the intervention group given aerobic exercise in the analysis before and after the intervention. Aerobic exercise effectively increases the volume of muscle fibers, improves the oxygen transport process by muscles, increases their capacity to oxidize and metabolize glucose, increases muscle resistance and increases the strength of respiratory muscles and peripheral muscles (Harber et al., 2009) (De Lima et al., 2013) Aerobic exercise can improve blood flow in chronic kidney disease patients both during hemodialysis and at the end of the session (de Oliveira et al., 2020)

### **Effects of aerobic exercise on biochemical physical condition**

Aerobic exercise during hemodialysis can maintain the stability of blood levels. This is in line with Dayananda's research (2024) that with aerobic exercise blood volume and hemoglobin increase and facilitate oxygen transport. Aerobic exercise helps increase the



heart's capacity to pump blood, which increases blood flow to working muscles. (Kemi & Wisløff, 2010) Blood vessels also become more efficient in transporting oxygen to muscle tissues. Aerobic exercise can increase hemoglobin levels in the blood. With more hemoglobin, the blood can transport more oxygen to the working muscles. (Dayananda, 2024)

## **CONCLUSION**

The effect of Aerobic exercise on the physical condition of patients is divided into physiological and biochemical effects. Aerobic exercise physiologically improves physical function, functional capacity and activity of the autonomic nervous system of the heart, increases blood flow, reduces risk factors for cardiovascular disease, increases cardiorespiratory capacity and muscle strength of the upper and lower body, and has a more comprehensive range of activities. The effect of Aerobic exercise on physical condition biochemically is to maintain stable blood levels.

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