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Exercise and Hypertension in Children with Chronic Kidney Disease - Review

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Abstract: ***In children and adults, the incidence of chronic kidney disease (CKD) has emerged as a global concern. CKD has an impact on activities of daily living. Children and adults tend to restrict themselves due to fatigue. Exercise has played an integral part in promoting health and maintaining wellness. Findings suggest that exercise is both safe and effective for blood pressure management in hypertensive children, and also an important implication for paediatric CKD care.***

Keywords: Chronic kidney disease (CKD), Paediatric hypertension, Exercise therapy, daily living limitations, blood pressure control

1. Introduction

Chronic kidney disease has emerged as a concern in today's world. Patients with this condition are vulnerable to progression toward end-stage renal disease and have a markedly elevated risk of cardiovascular complications and death. (Bruck et al, 2015)

Chronic kidney disease (CKD) is one of the noncommunicable diseases which is progressive and affects more than 10 percent of the population. It has become one of the leading causes of mortality across nations. The incidence of CKD in children ranges 15 to 74.7 per 1 million. (Warady BA, Chadha V. 2009) CKD in children has some unique characteristics compared to adults. CKD and kidney failure in children is due to congenital anomalies in the kidney and urinary tract. (Harada *et al.* 2022) The independent risk factors for CKD progression are hypertension and proteinuria. (Warady BA, Chadha V. 2009)

Exercise and renal blood flow

Renal blood flow (RBF) decreases during physical activity, and the extent of this reduction is directly related to the intensity of exercise. his decline occurs because blood is preferentially redistributed to the actively contracting skeletal muscles during exercise. Glomerular filtration rate (GFR) may show a slight transient increase at the onset of exercise, but it subsequently declines, particularly as exercise intensity rises. Additionally, the intrarenal release of paracrine hormones—including renin, angiotensin, and prostaglandins—as well as other regulators of fluid and electrolyte balance such as atrial natriuretic peptide, increases in proportion to exercise intensity. These hormonal changes influence renal tubular function to maintain electrolyte and volume homeostasis. (Master Sankar Raj et al, 2017)

Chronic muscle wasting, reduced muscle protein synthesis, and physical inactivity create a vicious cycle that accelerates muscle atrophy and leads to decreased exercise tolerance in individuals with CKD. Limited physical activity and restrictions in daily movements contribute further to muscle loss and decreased functional capacity. Even short periods of inactivity can have significant effects; studies have shown that restricting physical activity for as little as three weeks can result in a 26% reduction in VO_2max.

Exercise and Muscle Mass

Muscle atrophy is a major complication in chronic kidney disease (CKD), adversely affecting physical function and quality of life. This scoping review of 20 studies examined the role of exercise interventions in managing CKD-related muscle wasting. The findings indicate that aerobic, resistance, and combined exercise programs- typically of mild to moderate intensity, performed 2–3 times per week for 30–60 minutes- are beneficial. These interventions improve muscle strength, body composition, physical performance, and cardiopulmonary function. Among them, resistance training emerged as the most effective strategy. Overall, exercise interventions play a vital role in enhancing patient outcomes and should be integrated into routine CKD management. (Yin et al, 2024)

A systematic review and meta-analysis, including fifteen observational studies and five clinical trials, highlights significantly reduced cardiorespiratory fitness among children and adolescents with chronic kidney disease (CKD) compared to healthy peers. Except for pre-dialysis patients, those undergoing dialysis or transplantation showed notably lower fitness levels. Exercise interventions demonstrated improvement in functional capacity, particularly in six-minute walk distance, though evidence quality remains low. Overall, the findings emphasize the critical need to incorporate routine assessment of physical functioning in pediatric CKD care. Further high-quality research is required to establish stronger evidence for exercise-based interventions in improving cardiorespiratory outcomes in this population. (**Zhang et al, 2025)**

This pilot study examined the effects of acute exercise on inflammation and immune responses in children and adolescents with chronic kidney disease (CKD). Nine participants with stages III–V CKD performed moderate-intensity cycling after a graded exercise test. Results showed no significant changes in overall blood counts, but a notable increase in NKbright cells following exercise. Trends toward increased interleukin-6, reduced tumor necrosis factor-α, and a higher IL-6: TNF-α ratio suggest a shift toward an anti-

inflammatory response. These findings indicate that acute moderate exercise may promote a beneficial anti-inflammatory environment, supporting its potential role as a therapeutic strategy in pediatric CKD management (Lau et al , 2015).

Tozo et al. (2025) carried out a systematic review and meta-analysis of exercise programs in children and adolescents, reporting consistent reductions in blood pressure across diverse exercise modalities. School-based interventions showed a drastic reach and impact. The authors also concluded that exercise should be incorporated into pediatric hypertension management plans, with an individualized adaptations for children with CKD.

Zhou et al. (2025) synthesized a randomized controlled trial data on exercise and paediatric hypertension. The study found that moderate-to-large reductions in systolic blood pressure with supervised exercise programs. These also highlighted that combining exercise interventions with dietary or behavioural programs produced the largest improvements, and an approach that is particularly useful for children with CKD.

Guideline syntheses **(2024–2025, JACC/ACC and KDIGO)** emphasized the role of physical activity in significant cardiovascular risk reduction for CKD populations. These guidelines also recommended that age-appropriate exercise for hypertensive children, aiming for at least 150 minutes of moderate activity per week, adapted as per the disease stage and tolerance level. The recommendations provided a strong framework for integrating the exercise prescriptions into pediatric CKD care.

Hassan et al. (2024) based on network meta-analysis of randomized and quasi-experimental trials which examined the effects of physical activity interventions on blood pressure in children and adolescents. The study also found that school-based and community exercise programs significantly lowered the systolic blood pressure, with moderate-to-vigorous aerobic exercise proving most effective. The authors highlighted the importance of implementing structured exercise routines in hypertensive children, including those with CKD.

Correa et al. (2024) published the review in Frontiers in Physiology focusing on exercise and kidney disease outcomes. The review synthesized evidence showing that regular aerobic and resistance exercise reduces blood pressure, improves cardiovascular function, and enhances quality of life in CKD populations. Although data in children were limited, the authors emphasized that similar benefits are expected in pediatric CKD patients, provided the exercise programs are age-appropriate and are closely monitored.

Piggin et al. (2020–2024) reviewed the evidence on the physical activity in CKD and also argued that even low-intensity, regular physical activity had provided benefits for hypertensive children with CKD. They also reported improvements in blood pressure control, reduced fatigue, and better exercise tolerance in small-scale feasibility studies. The authors further stressed the importance of tailoring exercise prescriptions to children's growth, anemia status, and dialysis schedules.

Sun et al. (2023) conducted systematic review on the physical function in children and adolescents with CKD. The review in hand highlighted that exercise training improved the functional capacity and reduced the blood pressure in small cohort studies. Despite the limited randomized trial evidence, consistent findings suggested that structured exercise interventions should be integrated into pediatric nephrology programs as a safe intervention to hypertension management.

Garcia-Hermoso et al. (2020) evaluated a before-school exercise intervention program called "Active-Start" in children. The program involved the structured physical activity before classes and was shown to reduce both the systolic and diastolic blood pressure among the participants. Although not specific to CKD, the findings also demonstrated that incorporating structured activity into daily routines could be a feasible strategy for reducing hypertension in children.

Clinical feasibility studies (2018–2023) tested the tailored exercise regimens like intradialytic cycling, aerobic sessions, and combined resistance training in pediatric CKD patients. The studies also demonstrated further improvements in the functional capacity and quality of life, and, in several cases, it also showed distinctive reductions in ambulatory blood pressure. Although sample sizes were small, the findings confirmed that exercise is both safe and beneficial for the hypertensive children with CKD.

Randomized school-based programs (2017–2022) consistently demonstrated that blood pressure reductions in children through aerobic exercise, active classroom breaks, and also reducing sedentary behavior. While these studies were not CKD-specific, the models used in that studies can be adapted to pediatric CKD settings with clinical supervision, ensuring safety while maximizing the benefits for hypertension control.

Policy reviews (**Hyseni et al., 2017**) noted that the physical activity promotion through the school curricula, the community programs, and the urban planning was effective in lowering the paediatric blood pressure. They also argued that structural interventions are necessary to complement the individual clinical advice. For children with CKD and hypertension, integrating the policy-level supports with clinic-based exercise guidance may ensure sustained participation.

2. Conclusion

Regular exercise is safe and beneficial in children with chronic kidney disease and hypertension. It enhances the quality of life of children and decreases fatigue.

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