International Platform of Registered Systematic Review and Meta-analysis Protocols

INPLASY

Effects of Exercise Training in Experimental Chronic Kidney Disease: A Systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - N/A.

Review Stage at time of this submission - The review has not yet started.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 14 April 2026 and was last updated on 14 April 2026.

INTRODUCTION

Review question / Objective Does exercise training improve renal function, oxidative stress, inflammation, apoptosis, histopathological changes, and muscular outcomes in animal models of chronic kidney disease compared to sedentary controls?

Rationale Chronic kidney disease (CKD) is associated with progressive renal dysfunction, inflammation, and reduced physical function. Exercise training has been proposed as a non-pharmacological strategy to slow CKD progression, but evidence from experimental animal studies is inconsistent across animal models. Therefore, a systematic review and meta-analysis is needed to synthesize preclinical evidence and guide future translational research.

Condition being studied Chronic kidney disease (CKD).

METHODS

Search strategy A systematic literature search will be conducted in PubMed, Web of Science, and EMBASE.
Search terms will include combinations of:
• ("chronic kidney disease" OR "CKD" OR "renal failure")
• ("exercise" OR "exercise training" OR "physical activity")
• ("animal model" OR "rat" OR "mouse" OR "rodents")
These terms will be combined using Boolean operators (AND).

Participant or population Animal models (rats and mice) with chronic kidney disease induced by surgical (e.g., 5/6 nephrectomy), chemical (e.g., doxorubicin), or genetic methods.

Intervention All types of exercise training, including aerobic exercise (treadmill running, wheel running), resistance training (ladder climbing), and

swimming exercise, with a minimum duration of three weeks.

Comparator Sedentary chronic kidney disease (CKD) control group without exercise intervention.

Study designs to be included Controlled experimental animal studies.

Eligibility criteria • Animal studies (rats or mice)
• CKD models
• Exercise intervention ≥ 3 weeks
• Presence of a sedentary CKD control group
Exclusion Criteria:
• Human studies
• Combined interventions (exercise + drugs/diet)
• Intervention duration < 3 weeks
• Lack of relevant outcome data
• Non-English studies

• Reporting at least one relevant outcome.

Information sources A systematic literature search will be conducted in PubMed, Web of Science, and EMBASE. Reference lists of included studies and relevant reviews will also be screened to identify additional eligible studies.

Main outcome(s) • Renal function: (serum creatinine, BUN, GFR, proteinuria, Urea)
• Oxidative stress markers: SOD, CAT, GPx, MDA, TBARS (Thiobarbituric Acid Reactive Substances) Superoxide production, Protein carbonyl, Nitric oxide (NO) NADPH oxidase activity, Xanthine oxidase (XO) activity
• Apoptosis markers: (caspases, Bax/Bcl-2, TUNEL)
• Inflammatory markers: (TNF-α, IL-6, TGF-β, NF-κB) mTOR, PTEN, rpS6
• Histopathological changes: (Renal & Tubulointerstitial fibrosis, glomerular injury, Renal structural damage).

Additional outcome(s) • Physiological Function: Body weight and kidney weight, Blood pressure
• Muscular outcomes: Muscle mass and strength, cross sectional area.

Data management Data will be independently extracted by two reviewers using a standardized form. Reference records will be managed in the EndNote library. According to Prisma guidelines, extracted numerical and outcome data will be organized and stored in Microsoft Excel for analysis.

Quality assessment / Risk of bias analysis The methodological quality of included studies will be assessed using the CAMARADES 10-item checklist for animal studies.

Strategy of data synthesis Meta-analysis will be performed using RevMan software. Effect sizes will be calculated using mean difference (MD) or standardized mean difference (SMD) with 95% confidence intervals. A random-effects model will be applied. Heterogeneity will be assessed using the I^2 statistic.

Subgroup analysis Subgroup analyses will be conducted based on:
• Type of exercise (aerobic vs resistance vs swimming)
• Type of CKD model
• Outcome category.

Sensitivity analysis Sensitivity analysis will be performed using a leave-one-out approach to evaluate the robustness of the results.

Language restriction English only.

Country(ies) involved Taiwan.

Other relevant information N/A

Keywords chronic kidney disease; exercise; inflammation; oxidative stress; apoptosis.

Dissemination plans The findings of this systematic review and meta-analysis will be disseminated through publication in a peer-reviewed journal, presentation at the scientific community, and academic platforms to inform future preclinical and translational CKD research.

Contributions of each author

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