Supplementary Material

1 Supplementary Data

1.1 Checklist for umbrella reviews

Section Topic	#	Item	Location reported
TITLE			
Title	1	Identify the report as an overview of reviews.	Pg 1
ABSTRACT			
Abstract	2	Provide a comprehensive and accurate summary of the purpose, methods, and results of the overview of reviews.	Pg 2
INTRODUCTION			
Rationale	3	Describe the rationale for conducting the overview of reviews in the context of existing knowledge.	Pg 3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) addressed by the overview of reviews.	Pg 3
METHODS			
Eligibility criteria	5a	Specify the inclusion and exclusion criteria for the overview of reviews. If supplemental primary studies were included, this should be stated, with a rationale.	Pg 4
	5b	Specify the definition of 'systematic review' as used in the inclusion criteria for the overview of reviews.	Pg 4
Information sources	6	Specify all databases, registers, websites, organizations, reference lists, and other sources searched or consulted to identify systematic reviews and supplemental primary studies (if included). Specify the date when each source was last searched or consulted.	Pg 4

Search strategy	7	Present the full search strategies for all databases, registers and websites, such that they could be reproduced. Describe any search filters and limits applied.	Pg 4
Selection process	8a	Describe the methods used to decide whether a systematic review or supplemental primary study (if included) met the inclusion criteria of the overview of reviews.	Pg 4 - 5
	8b	Describe how overlap in the populations, interventions, comparators, and/or outcomes of systematic reviews was identified and managed during study selection.	Pg 4 - 5
Data collection process	9a	Describe the methods used to collect data from reports.	Pg 4 - 5
	9b	If applicable, describe the methods used to identify and manage primary study overlap at the level of the comparison and outcome during data collection. For each outcome, specify the method used to illustrate and/or quantify the degree of primary study overlap across systematic reviews.	NA
	9c	If applicable, specify the methods used to manage discrepant data across systematic reviews during data collection.	NA
Data items	10	List and define all variables and outcomes for which data were sought. Describe any assumptions made and/or measures taken to identify and clarify missing or unclear information.	Pg 4 – 5
Risk of bias assessment	11a	Describe the methods used to _assess_ risk of bias or methodological quality of the included systematic reviews.	Pg 5
	11b	Describe the methods used to _collect_ data on (from the systematic reviews) and/or _assess_ the risk of bias of the primary studies included in the systematic reviews. Provide a justification for instances where flawed, incomplete, or missing assessments are identified but not re-assessed.	Pg 5
	11c	Describe the methods used to _assess_ the risk of bias of supplemental primary studies (if included).	NA
Synthesis methods	12a	Describe the methods used to summarize or synthesize results and provide a rationale for the choice(s).	Pg 4 – 5
	12b	Describe any methods used to explore possible causes of heterogeneity among results.	Pg 5
	12c	Describe any sensitivity analyses conducted to assess the robustness of the synthesized results.	Pg 5
Reporting bias assessment	13	Describe the methods used to _collect_ data on (from the systematic reviews) and/or _assess_ the risk of bias due to missing results in a summary or synthesis (arising from reporting biases at the levels of the systematic reviews, primary studies, and supplemental primary studies, if included).	Pg 4 – 5
Certainty assessment	14	Describe the methods used to _collect_ data on (from the systematic reviews) and/or _assess_ certainty (or confidence) in the body of evidence for an outcome.	Pg 4 – 5

RESULTS			
Systematic review and supplemental primary study selection	15a	Describe the results of the search and selection process, including the number of records screened, assessed for eligibility, and included in the overview of reviews, ideally with a flow diagram.	Pg 6 – 7
	15b	Provide a list of studies that might appear to meet the inclusion criteria, but were excluded, with the main reason for exclusion.	Pg 6 – 7

Section Topic	#	Item	Location reported
Characteristics of systematic reviews and supplemental primary studies	16	Cite each included systematic review and supplemental primary study (if included) and present its characteristics.	Pg 6
Primary study overlap	17	Describe the extent of primary study overlap across the included systematic reviews.	
Risk of bias in systematic reviews, primary studies, and supplemental primary studies	18a	Present assessments of risk of bias or methodological quality for each included systematic review.	Pg 6
	18b	Present assessments (_collected_ from systematic reviews or _assessed_ anew) of the risk of bias of the primary studies included in the systematic reviews.	Pg 6
	18c	Present assessments of the risk of bias of supplemental primary studies (if included).	NA
Summary or synthesis of results	19a	For all outcomes, summarize the evidence from the systematic reviews and supplemental primary studies (if included). If meta-analyses were done, present for each the summary estimate and its precision and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Pg 7
	19b	If meta-analyses were done, present results of all investigations of possible causes of heterogeneity.	NA
	19c	If meta-analyses were done, present results of all sensitivity analyses conducted to assess the robustness of synthesized results.	NA
Reporting biases	20	Present assessments (_collected_ from systematic reviews and/or _assessed_ anew) of the risk of bias due to missing primary studies, analyses, or results in a summary or synthesis (arising from	NA

		reporting biases at the levels of the systematic reviews, primary studies, and supplemental primary studies, if included) for each summary or synthesis assessed.	
Certainty of evidence	21	Present assessments (*collected* or *assessed* anew) of certainty (or confidence) in the body of evidence for each outcome.	Pg 7
DISCUSSION			
Discussion	22a	Summarize the main findings, including any discrepancies in findings across the included systematic reviews and supplemental primary studies (if included).	Pg 8
	22b	Provide a general interpretation of the results in the context of other evidence.	Pg 8
	22c	Discuss any limitations of the evidence from systematic reviews, their primary studies, and supplemental primary studies (if included) included in the overview of reviews. Discuss any limitations of the overview of reviews methods used.	Pg 10
	22d	Discuss implications for practice, policy, and future research (both systematic reviews and primary research). Consider the relevance of the findings to the end users of the overview of reviews, e.g., healthcare providers, policymakers, patients, among others.	Pg 9 – 10
OTHER INFORMATION			
Registration and protocol	23a	Provide registration information for the overview of reviews, including register name and registration number, or state that the overview of reviews was not registered.	Pg 4
	23b	Indicate where the overview of reviews protocol can be accessed, or state that a protocol was not prepared.	Pg 4
	23c	Describe and explain any amendments to information provided at registration or in the protocol. Indicate the stage of the overview of reviews at which amendments were made.	Pg 4
Support	24	Describe sources of financial or non-financial support for the overview of reviews, and the role of the funders or sponsors in the overview of reviews.	Pg 12
Competing interests	25	Declare any competing interests of the overview of reviews' authors.	Pg 12
	26a	Provide contact information for the corresponding author.	Pg 1

Author information	26b	Describe the contributions of individual authors and identify the guarantor of the overview of reviews.	Pg 12
Availability of data and other materials	27	Report which of the following are available, where they can be found, and under which conditions they may be accessed: template data collection forms; data collected from included systematic reviews and supplemental primary studies; analytic code; any other materials used in the overview of reviews.	Pg 12

2 Supplementary Tables

Table S1. comprehensive overview

Characteristic	N = 275
Studies.total (mean, IQR)	13 (9, 22)
Disease.stage	
Both	45 (16%)
End-stage CKD undergoing hemodialysis	187 (68%)
Pre-dialysis stage	43 (16%)
Population.total (mean, IQR)	546 (342, 825)
Exercise modality	
Aerobic.ex	59 (21%)
Combined.ex	55 (20%)
Ems.ex	12 (4.4%)
Home-based.ex	16 (5.8%)
Isometric.ex	7 (2.5%)
Isotonic.ex	97 (35%)
Resistance.ex	27 (9.8%)
Respiratory	2 (0.7%)
Outcomes	
Blood pressure	36 (13%)
Body composition	5 (1.8%)
Cardiorespiratory fitness	25 (9.1%)
Clinical	46 (17%)
Fistula maturation	17 (6.2%)
Functional performance	49 (18%)
Inflammation	22 (8.0%)
Kidney function	11 (4.0%)

Mortality	3 (1.1%)
Psychosocial	11 (4.0%)
Quality of life	45 (16%)
Sleep quality	2 (0.7%)
Vascular function	3 (1.1%)
Country	
Australia	15 (5.5%)
Belgium	4 (1.5%)
Brazil	87 (32%)
Canada	3 (1.1%)
China	104 (38%)
Italy	1 (0.4%)
Japan	13 (4.7%)
London	1 (0.4%)
Singapore	1 (0.4%)
Slovenia	1 (0.4%)
Spain	25 (9.1%)
Taiwan	7 (2.5%)
Thailand	7 (2.5%)
United Kingdom	6 (2.2%)
I^2	
<25%	144 (52%)
>50%	90 (33%)
Between 25 - 50%	41 (15%)
P value	
$<10^{-6}$	30 (11%)
$<10^{-3}$	61 (22%)
<0.05	38 (14%)
Ns	146 (53%)
Grading	
Ns	138 (50%)
Weak	59 (21%)
Suggestive	50 (18%)
Highly suggestive	5 (1.8%)
Strong	23 (8.4%)

Table S2. Diverse Spectrum of Investigated Outcomes and Corresponding Metrics

Outcomes	Measure
Blood pressure	Systolic and diastolic blood pressure
Body composition	waist circumference, Body mass index, muscle mass
Cardiorespiratory fitness	VO2peak
Others	albumin, albumin/cr ratio, cholesterol, HDL, Hemoglobin, ktv, LDL, phosphorus, proteinuria, proteinuria/cr ratio, creatinine, triglycerides, urea clearance
Fistula maturation	blood flow in the inflow artery, clinical maturation, ultrasound maturation vascular access complications, vein blood flow rate, venous diameter
Functional performance	handgrip strength, leg mass, lower limbs strength (isometric quadriceps, knee extensor, quadriceps, sit-to-stand repetitions), muscle mass, muscular strength, sit-to-stand test, six-minute walking test, timed-up and go test, upper limbs strength
Inflammation	C-reactive peptide, IL10, IL6, TNF
Kidney function	eGFR
Mortality	All-cause mortality
Psychosocial	anxiety symptoms, cognitive function, depression symptoms, fatigue
Quality of life	body pain, general health, mental health, physical function, role emotional, role mental, role physical, social function, vitality
Sleep quality	restless legs syndrome (severity), sleep quality (overall)
Vascular function	pulse wave velocity, augmentation index, pulse wave velocity

Table S3. Characteristics of the interventions presented in the included meta-analysis

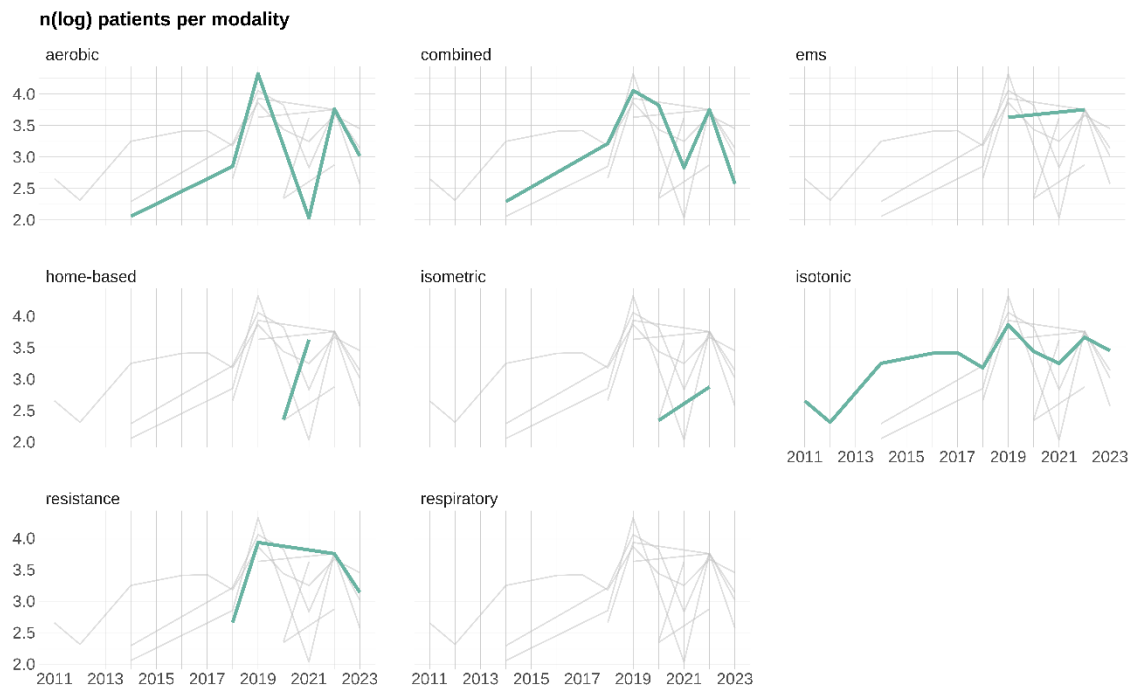|	Total	Aerobic, n = 59	Combined, n = 55	EMS, n = 12	Home-based, n = 16	Isometric, n = 7	Isotonic, n = 97[a]	Resistance, n = 27	Respiratory, n = 2
Number of Meta-analyses	275 (100%)	59 (21%)	55 (20%)	12 (4.2%)	16 (5.6%)	7 (2.4%)	97 (34%)	27 (9.4%)	2 (0.7%)
Number of studies	13	31	7	10	8	5	14	2	2
(Median, min - max)	(4 - 56)	(7 - 56)	(6 - 21)	(10 - 10)	(8 - 8)	(5 - 5)	(4 - 33)	(2 - 8)	(2 - 2)
Number of participants	546	1,280	306	242	621	413	565	108	42
(Median, min - max)	(124 - 2,586)	(124 - 2,586)	(282 - 331)	(242 - 242)	(621 - 621)	(413 - 413)	(179 - 1,274)	(77 - 390)	(42 - 42)
Outcomes									
blood pressure	36 (100%)	11 (29%)	7 (19%)	2 (5.3%)	0 (0%)	0 (0%)	10 (26%)	6 (16%)	0 (0%)
body composition	5 (100%)	0 (0%)	2 (40%)	0 (0%)	0 (0%)	0 (0%)	3 (43%)	0 (0%)	0 (0%)
cardiorespiratory fitness	25 (100%)	8 (31%)	7 (28%)	0 (0%)	0 (0%)	0 (0%)	10 (38%)	0 (0%)	0 (0%)
others	46 (100%)	14 (29%)	8 (1722%)	2 (4.1%)	0 (0%)	0 (0%)	16 (33%)	6 (12%)	0 (0%)
fistula maturation	17 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (41%)	10 (59%)	0 (0%)	0 (0%)
functional performance	49 (100%)	7 (13%)	9 (18%)	7 (13%)	4 (7.7%)	0 (0%)	12 (23%)	8 (15%)	2 (3.8%)
Inflammatory markers	22 (100%)	6 (27%)	4 (18%)	0 (0%)	0 (0%)	0 (0%)	7 (32%)	5 (23%)	0 (0%)
kidney function	11 (100%)	1 (8.3%)	3 (27%)	0 (0%)	2 (17%)	0 (0%)	5 (42%)	0 (0%)	0 (0%)
mortality	3 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (33%)	0 (0%)	2 (67%)	0 (0%)	0 (0%)
psychosocial	11 (100%)	1 (9.1%)	4 (36%)	0 (0%)	1 (9.1%)	0 (0%)	5 (45%)	0 (0%)	0 (0%)
quality of life	45 (100%)	10 (22%)	11 (24%)	1 (2.2%)	8 (18%)	0 (0%)	13 (29%)	2 (4.4%)	0 (0%)
sleep quality	2 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
vascular function	3 (100%)	1 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (67%)	0 (0%)	0 (0%)
Disease stage									
Both	45 (100%)	20 (44%)	6 (13%)	0 (0%)	4 (8.9%)	0 (0%)	11 (24%)	4 (8.9%)	0 (0%)
ESKD – Hemodialysis	187 (100%)	37 (20%)	35 (19%)	12 (6.4%)	7 (3.7%)	7 (3.7%)	64 (34%)	23 (12%)	2 (1.1%)
Pre-dialysis stages (Stage 1 – 4)	43 (100%)	2 (3.6%)	14 (33%)	0 (0%)	5 (9.1%)	0 (0%)	22 (40%)	0 (0%)	0 (0%)

Figure S1. Insights into the number of patients analyzed in the included systematic reviews based on exercise modalities. Log-ranked patient numbers (y-axis) per exercise modality over time (x-axis)
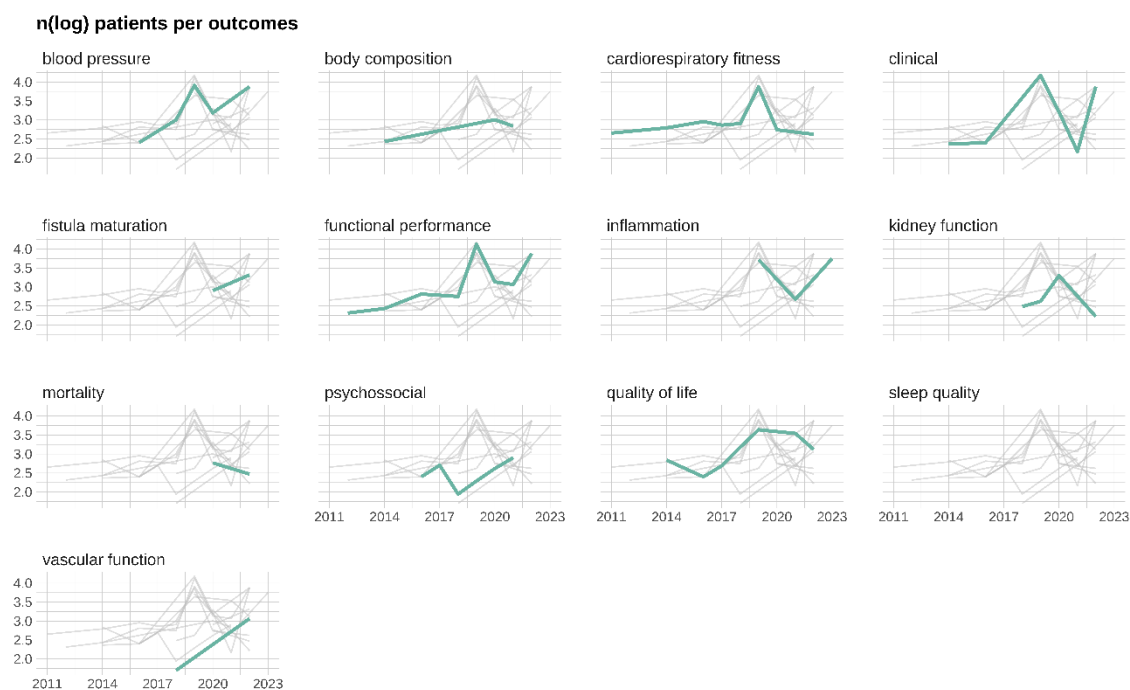
Figure S2. The number of patients in the included studies according to different outcomes. Log-ranked patient numbers (y-axis) per outcomes over time (x-axis)