STATENS BEREDNING FÖR MEDICINSK OCH SOCIAL UTVÄRDERING

Bilaga till rapport

Fysisk träning vid postcovid - en systematisk översikt/Physical Exercise in Post-COVID Condition – A Systematic Review, rapport 414 (2026)

Bilaga 3 Inkluderade studier med låg eller måttlig risk för bias/Appendix 3 Included studies with low or moderate risk of bias

Bai et al 2024

Author	Bai et al. [1]
Year	2024
Country	China
Study design	Randomised controlled trial (single-center, parallel-group, open-label)
Setting	Cardiac rehabilitation clinic at Guangdong Provincial People's Hospital, Southern Medical University, Guangzhou, China
Population	24 patients aged 18–75 years (mean age 46.5 years) with long COVID symptom such as fatigue, cognitive impairment, chest discomfort, etc., persisting ≥2 months post-infection; 58.3% female; median time from COVID-19 diagnosis to enrollment was 14 weeks
Inclusion criteria	History of SARS-CoV-2 infection; symptoms persisting ≥2 months post-infection; positive RT-PCR or antigen test with negative result ≥4 weeks before inclusion; symptoms include at least one of such as cough, fatigue, cognitive impairment, chest tightness, palpitations, etc
Exclusion criteria	Conditions worsened by exercise (acute cardiac insufficiency, exercise-induced asthma, epilepsy); serious comorbidities (unstable angina, oxygen saturation <93%, uncontrolled arrhythmia, uncontrolled hypertension or type 2 diabetes); physical disabilities due to bone/joint or neuromuscular diseases; pregnancy or lactation
Intervention Participants (n) Drop-outs (n)	Training group 4-week supervised aerobic training on cycling ergometer, 3 sessions/week (12 sessions total), using moderate- or high-intensity interval training based on peak VO_2 and work rate 12 0
Control Participants (n) Drop-outs (n)	Control group: standard healthy lifestyle guidance and WHO self-management recommendations 12 0
Follow-up time points	Baseline and 4 weeks (post-intervention) assessments using CPET and questionnaires (SF-12, PHQ-9, GAD-7, ISI, PSS)
Outcomes measured	Primary: Changes in persistent symptoms (total number, specific symptoms) Secondary: Cardiopulmonary fitness (peak VO_2, AT VO_2, exercise time, maximum load, O_2 pulse, HR_{max}) and mental health (PHQ-9, GAD-7, stress, insomnia, SF-12 scores)
Results	VO_2 peak, mean (SD) at post treatment: I: 25.13 (5.12) C: 24.24 (6.47) FEV1 %, mean (SD) at post treatment: I: 98.83 (11.13) C: 97.18 (10.35) Depression, PHQ-9 mean (SD) post treatment:

	I: 3.25 (3.28) C: 6.67 (4.74) Anxiety, GAD-7 mean (SD) post treatment: I: 1.67 (2.46) C: 5.42 (4.03) Quality of life, SF-12 PCS, mean change from baseline (95% CI): I: 0.55 (–2.13 to 3.23) C: 0.01 (–4.78 to 4.79) Quality of life, SF-12 MCS, mean change from baseline (95% CI): I: –0.13 (–5.76 to 5.50) C: –0.50 (–5.62 to 4.63)
Limitations Noted	Small sample size; single-center; short duration (4 weeks) with no long-term follow-up; lack of stratified analysis for comorbidities; no detailed scale assessment of baseline exercise habits
Risk of bias	Moderate

Berenguel Senén et al. 2024

Author	Berenguel Senén et al. [2]
Year	2024
Country	Spain
Study design	Open label RCT
Setting	Outpatient care
Population	Adults 18–65 years (mean 47 years, SD; 7.1, 73% female) with a history of COVID-19 >12 weeks after infection and with asthenia and dyspnea on exertion
Follow-up	After treatment, at 8 weeks
Intervention Participants (n) Drop-outs (n)	Therapeutic exercise training with both inhouse modality and a modality conducted at home with remote monitoring. Training was performed twice daily, six days a week for 8 weeks. 25 7
Control Participants (n) Drop-outs (n)	The control group received recommendations on physical exercise and healthy habits based on recommendations for the general population 25 6
Outcomes and results	VO_2 peak, mean (SD) at post treatment: I: 29.3 (4.6) C: 24.8 (7.2) FEV1 %, mean (SD) at post treatment: I: 99.2 (11) C: 95.2 (15.1) Depression, PHQ-9, mean (SD) post treatment: I: 6 (4.02) C: 9.67 (7.21)
Comments	Authors do not perform intention to treat analyses
Risk of bias	Moderate

Berry et al. 2025

Author	Berry et al. [3]
Year	2025
Country	Scotland, United Kingdom
Study design	Multicenter, parallel-group randomised clinical trial (1:1 allocation)
Setting	Queen Elizabeth University Hospital (Glasgow), Royal Infirmary (Glasgow), and Ninewells Hospital (Dundee), Scotland
Population	Adults with confirmed COVID 19 infection within the preceding 12 months and persistent symptoms; median age: 53.6 years; 62.7% female; 39.1% previously hospitalized for COVID 19
Inclusion Criteria	Confirmed COVID 19 diagnosis (PCR, point-of-care test, lateral flow test, antibody test, or radiology); diagnosis within the past 12 months; persistent symptoms ≥4 weeks; categorized as community symptomatic (group A), post-hospital discharge with persistent symptoms (group B), or convalescing in hospital (group C)
Exclusion Criteria	Receiving inpatient physiotherapy after ICU stay; no expectation of being able to walk within 3 months; inability to provide informed consent; inability to comply with the study protocol; pregnancy
Intervention Participants (n) Dropouts (n)	Personalized resistance exercise program for 3 months; including guidance document, exercise log, instructional videos and initial face to face consultation with exercise physiologist/therapist; follow-up support every 2 weeks via phone or video; exercises included chest press, rows, lateral raises, squats, lunges, calf raises; daily exercise targeting perceived exertion levels of 8–10 117 22
Control Participants (n) Dropouts (n)	Usual care according to long COVID clinical guidelines without additional research contact. 116 16
Follow-up Timepoints	Baseline and 3 months after randomisation.
Outcomes measured	<u>Primary outcome:</u> Distance achieved with ISWT at 3 months <u>Secondary outcomes:</u> Spirometry (FVC, FEV1, peak flow), handgrip strength, Short Physical Performance Battery, Duke Activity Status Index, accelerometry based physical activity, quality of life (EQ 5D 5L), anxiety/depression (PHQ 4), illness perception questionnaire, fatigue severity, dyspnea (MRC scale), hospitalisation, adverse events, and post-exertional malaise
Results	<u>Fatigue, FSS, mean difference (95% CI) between groups:</u> –2.60 (–6.38 to 1.18) <u>Quality of life (health-related), EQ-5D-5L, mean difference (95% CI) between groups:</u> 0.062 (0.011 to 0.113) <u>Quality of life (health-related), EQ VAS, mean difference (95% CI) between groups:</u> 3.6 (–0.7 to 8.0)
Limitations	Outcome assessors aware of treatment allocation; exercise intervention unsupervised; adherence self-reported; control group had fewer contacts with research staff; study not powered for subgroup interaction analyses; no ITT-analysis.
Risk of bias	Moderate

Besnier et al. 2025 & Gaudreau-Majeau et al. 2024

Author	Besnier et al. [4] Gaudreau-Majeau et al. [5] Two articles reporting results from same study.
Year	2025, 2024
Country	Canada
Study design	Randomised controlled trial (two-arm, parallel-group)
Setting	Centre ÉPIC, Montreal Heart Institute, Montreal, Quebec, Canada
Population	40 individuals with long COVID; mean age 53; symptoms persisting ≥3 months post-infection; included fatigue, breathlessness, cognitive issues; 72% female in control group and 65% female in rehabilitation group
Inclusion criteria	Age ≥40 years; positive PCR test for SARS-CoV-2; persistent dyspnea and/or fatigue ≥3 months after infection; 1-point increase in dyspnea on Modified Medical Research Council scale compared to pre-infection period; no contraindication to exercise rehabilitation testing/training; able to give informed consent
Exclusion criteria	Pulmonary embolism; contraindications to cardiopulmonary stress tests/exercise training; severe exercise intolerance; significant myocardial ischemia or arrhythmia; severe pulmonary hypertension; severe respiratory disease; recent cardiovascular events; heart failure NYHA III/IV; kidney failure requiring dialysis
Intervention Participants (n) Drop-outs (n)	Rehabilitation group 8-week individualized, supervised cardiopulmonary rehabilitation (3 sessions/week of aerobic + resistance + daily inspiratory muscle training). 20 2 in Besnier et al; 5 in Gaudreau-Majeau et al.
Control Participants (n) Drop-outs (n)	Control group maintained daily habits; rehabilitation offered after study completion. 20 3
Follow-up time points	Baseline and 8 weeks post-intervention assessments (CPET, functional tests, quality of life questionnaires including SF-36, Post-COVID Functional Scale, Medical Research Council Breathlessness Scale, and symptom impact tools)
Outcomes measured	Primary: Change in VO_2 peak (mL/kg/min) via CPET. Secondary: Submaximal CPET parameters (VE/VCO_2 slope, ventilatory thresholds), functional tests (6-Minute Walking Test, Timed Up and Go, Sit-to-Stand), quality of life (SF-36 physical and mental component scores), and symptom impact scales (personal, family, professional, social life, mood).
Results	VO_2 peak, mean (SD) at post treatment: I: 22.82 (5.57) C: 18.62 (3.77) 6MWT, mean change from baseline (95% CI): I: 47.7 (8.9 to 86.5) C: -27.5 (-67.6 to 12.5) Depression, GDS, mean (SD) post treatment (in Gaudreau-Majeau): I: 12.14 (8.55) C: 14.38 (7.88) Quality of life, SF-36 PCS, mean (SD) post treatment: I: 38.95 (8.40) C: 34.57 (8.36) SF-36 PCS, mean (SD) post treatment: I: 41.36 (13.22) C: 43.29 (14.19)
Limitation Noted	Small sample size; predominantly Caucasian participants; short follow-up (8 weeks); lack of evaluation of alternative rehabilitation modalities; no stratified analysis for sex differences; potential variability from SARS-CoV-2 variants and vaccination status. Authors state that missing values were not imputed, and

	analysis was conducted on an intention-to-treat basis. It seems analysis was performed on complete cases only.
Risk of bias	Moderate

Calvo-Paniagua et al. 2024

Author	Calvo-Paniagua et al. [6]
Year	2024
Country	Spain
Study design	RCT
Setting	Home-based tele-rehabilitation implemented by videoconference
Population	Adults 25–70 years (mean age about 49.4-50.8, women about 31.3-43.8%)) with moderate respiratory and/or functional impairments starting after the acute SARS-CoV-2 infection (mean duration after infection: 14.8 ± 1.7 months), at least 93% of oxygen saturation by pulse oximetry at rest on room air, n=64
Follow-up	Post-intervention and 1 and 3 months after post-intervention.
Intervention Participants (n) Drop-outs (n)	A tele-rehabilitation program based on patient education, physical activity, airway clearing, and breathing exercise interventions, 18 sessions (40 minutes per session) in 7 weeks 32 0
Control Participants (n) Drop-outs (n)	Waitlist 32 0
Outcomes	6MWT, mean change from baseline (95% CI): I: 126.5 (38.7 to 214.3) C: –40.1 (–105.4 to 25.1)
Comments	Not fulfilling the WHO criteria completely but the average post-infection time was 14.8 ± 1.7 months
Risk of bias	Moderate

Capin et al. 2022

Author	Capin et al. [7]
Year	2022
Country	USA
Study design	RCT
Setting	Home environment/outside health care setting
Population	Adults (mean age 52 years, 47.7% female) discharged from hospital due to confirmed COVID-19 (with and without ICU stay)
Follow-up	6 and 12 weeks
Intervention Participants (n) Drop-outs (n)	Multicomponent app-facilitated telerehabilitation program with e.g. physical exercises and lifestyle coaching, 12 individual sessions with licensed physical therapist during 9–10 weeks. 29 1
Control Participants (n) Drop-outs (n)	No additional exercise equipment compared to material initially provided to both groups; educational handout about recovery from COVID-19 and weekly check-in phone calls. 15 3
Outcomes and results	Depression, PHQ-8, mean (SD) post treatment: I: 8 (6) C: 6 (4)
Comments	Assessor-blinded RCT
Risk of bias	Moderate

Daynes et al. 2025

Author	Daynes et al. [8]
Year	2025
Country	United Kingdom
Study design	Single-blind, three-arm randomised controlled trial
Setting	University of Leicester and Northumbria University; specialist outpatient post-COVID clinics
Population	Adults ≥18 years, previously hospitalised with COVID-19; n=181 randomised; mean age 59; 55% male
Inclusion criteria	≥18 years; hospitalised with confirmed COVID-19; symptoms >12 weeks; functional impairment; diagnosed with post-COVID syndrome
Exclusion criteria	Contraindications to exercise; suspected alternative diagnoses (e.g., severe PEM/PESE, POTS); unstable comorbidities; completed rehab in prior 6 months
Intervention Participants (n) Drop-outs (n)	Face-to-face rehabilitation, twice weekly for 8 weeks including exercise, education and self-management strategies 56 11
Intervention Particpiants (n) Drop-outs (n)	Remote rehabilitation for 8 weeks, including exercise and self-directed symptom management advice 63 17
Control Participants (n) Drop-outs (n)	Usual care, individually tailored without exercise rehabilitation 62 2
Follow-up time points	Baseline and 8 weeks post-intervention
Outcomes measured	<u>Primary:</u> Incremental Shuttle Walking Test (ISWT) change. <u>Secondary:</u> SPPB, 4-m gait speed, quadriceps strength, handgrip strength, EQ-5D-5L, PHQ-9, GAD-7, FACIT-FS, MoCA, DePaul Symptom Questionnaire, Dyspnoea-12, BPI
Results	<u>Depression, PHQ-9, mean (95% CI) post treatment:</u> I: 7.78 (6.19 to 9.37) C: 8 (6.48 to 9.52) <u>Anxiety, GAD-7, mean (95% CI) post treatment:</u> I: 6.27 (4.76 to 7.78) C: 6.00 (4.54 to 7.46) <u>Quality of life (health related), EQ-5D-5L, mean difference (95% CI) between groups:</u> –0.02 (–0.11 to 0.07) <u>Quality of life (health related), EQ VAS, mean difference (95% CI) between groups:</u> –1.08 (–7.65 to 5.46)
Limitations Noted	Only hospitalised during acute Covid population; baseline differences due to access-based randomisation; some digital exclusion; no long-term follow-up; HRQoL tools may be insensitive; small immune substudy sample
Risk of bias	Moderate

Elgayar et al. 2025

Author	Elgayar et al. [9]
Year	2025
Country	Egypt
Study design	Parallel-group, single-center, prospective, randomised controlled trial
Setting	Physical therapy unit, Al Mahalla Al Kobra Chest Hospital, Egypt
Population	Men aged 40–60 years with chronic post-COVID-19 pulmonary fibrosis (PC19-PF)
Inclusion criteria	Male sex; age 40–60 years; mild–moderate PC19-PF (grade 1–3); moderate-to-severe prior COVID-19 (WHO-CPS 4–9); fibrosis >6 months; MRC dyspnea grade 1–3; BMI 18.5–29.9 kg/m²
Exclusion criteria	Other chronic chest disease; unstable cardiovascular disease; smoking; oxygen therapy; neurological or musculoskeletal disorders affecting exercise; other medical contraindications.
Intervention Participants (n) Drop-outs (n)	AE/RE + DBE: combined aerobic (55–70% HRmax) and resistance (55–65% 1RM) exercise + DBE, 3×/week for 12 weeks. 20 0
Control Participants (n) Drop-outs (n)	DBE only 20 1
Follow-up time points	Baseline and post-intervention (12 weeks)
Outcomes measured	Primary: Ventilatory function (FVC, DLCO). Secondary: Fibrosis grade (CT), exercise capacity (estimated VO_2max), dyspnea (MRC scale), quality of life (SF-12 PCS and MCS).
Results	VO_2 peak, mean difference (95% CI) between groups: 9.1 (3.6 to 14.6) Quality of life, SF-12 PCS, mean difference (95% CI) between groups: 7.4 (2.8 to 11.9) Quality of life, SF-12 MCS, mean difference (95% CI) between groups: 8.4 (3.3 to 13.4)
Limitations Noted	Male-only sample; single-center design; assessors not blinded for some outcomes; VO_2max estimated rather than directly measured; short-term follow-up only.
Comments	Study has four arms but only groups AE+RE and control are included in analyses.
Risk of bias	Moderate

Elhamrawy et al. 2023

Author	Elhamrawy et al. [10]
Year	2023
Country	Egypt
Study design	RCT, 3-arm
Setting	Supervised exercise sessions.
Population	Adults aged ≥60 years (mean age 65.7±3.6 (I1), 66.2±3.8 (I2) and 66.3±4 (control), 35.2% female) with COVID-19 with mild-to-moderate symptoms according to PCFS; 18 ≥3 months post-recovery.
Follow-up	Post-treatment
Intervention 2 Participants (n) Drop-outs (n)	Four supervised 60-minute aerobic training sessions weekly for 12 weeks 18 0
Control Participants (n) Drop-outs (n)	Maintaining their usual ADLs 18 0
Outcomes and results	Fatigue, FSS; mean difference (SE) between groups: 6 (1.2)
Comments	Study has three arms but only aerobic training and maintain usual ADL are included in analyses
Risk of bias	Low

Ibrahim et al. 2023

Author	Ibrahim et al. [11]
Year	2023
Country	Saudi Arabia
Study design	Block RCT
Setting	Outpatient setting
Population	Adults aged 60–80 (mean 62.6, 56.9% female, 23.6% with mild illness, 37.3% pneumonia, 37.5% severe penumonia).
Follow-up	Not completely fulfilling WHO criteria for post COVID-19 (long covid)
Intervention Participants (n) Drop-outs (n)	Moderate intensity aerobic exercises 4 times per week for 10 weeks 24 0
Control Participants (n) Drop-outs (n)	Medical care and advice 24 0
Outcomes and results	6MWT, mean difference (95% CI) between groups: 19.88 (10.13 to 29.62)
Comments	Study has three arms but only moderate intensity aerobic exercises and medical care and advice are included in analyses.
Risk of bias	Low

Jimeno-Almazan et al. 2022

Author	Jimeno-Almazan et al. [12]
Year	2022
Country	Spain
Study design	VO_2-max stratified RCT
Setting	University medical center
Population	Non-hospitalised adults (45.2±9.5 years, 74.4% female) with confirmed COVID-19 and a chronic symptomatic phase, lasting >12 weeks from onset of symptoms.
Follow-up	End of treatment (8 weeks)
Intervention Participants (n) Drop-outs (n)	Training 3 days/week for 8 weeks: 2 days of resistance training combined with moderate intensity variable training and 1 day of light intensity continuous training. 19 Not mentioned
Control Participants (n) Drop-outs (n)	WHO guidelines: Support for Rehabilitation: Self-Management after COVID-19 Related Illness, see comment. 20 Not mentioned
Outcomes and results	VO_2 peak, mean (SD) at post treatment: I: 38.9 (10.8) C: 36.1 (9.5) Pulmonary function, FEV1 % mean (SD) at post treatment: I: 108.5 (16.8) C: 103.3 (18.9) Depression, PHQ-9, mean (SD) post treatment: I: 5.0 (4.0) C: 8 (4.9) Anxiety, GAD-7, mean (SD) post treatment: I: 4.7 (3.8) C: 7.3 (4.7) Quality of life, SF-12 PCS, mean (SD) post treatment: I: 47.8 (10.6) C: 41.2 (11.2) SF-12 MCS, mean (SD) post treatment: I: 49.3 (9.7) C: 43.5 (10.9) Fatigue, FSS, mean (SD) post treatment: I: 3.4 (1.7) C: 4.7 (1.5)
Comments	WHO guidelines: support for rehabilitation involves recommendation of aerobic exercise for 20–30 minutes 5 times a week.
Risk of bias	Moderate

Kaddoussi et al. 2024

Author	Kaddoussi et al. [13]
Year	2024
Country	Tunisia
Study design	Randomised controlled trial (single-blinded)
Setting	Outpatient departments of pulmonology and physical medicine & rehabilitation, Fattouma Bourguiba Hospital, Monastir, Tunisia
Population	36 adult long-COVID-19 patients with persistent dyspnoea ≥3 months post-diagnosis; mean age 52–53 years; mix of sexes; comorbidities include diabetes, hypertension; excluded active smokers; varying lung injury extents on CT
Inclusion criteria	Confirmed COVID-19; age >18; persistent dyspnoea ≥3 months post-diagnosis; mMRC dyspnoea score ≥2
Exclusion criteria	Pre-existing chronic lung diseases (asthma, COPD, lung cancer); moderate/advanced heart failure; mobility-limiting conditions; active cigarette/narghile smokers; contraindications to 6MWT or spirometry; missed sessions or evaluations
Intervention Participants (n) Drop-outs (n)	Ambulatory cardiopulmonary rehabilitation program (CPRP) – 18 sessions over 6 weeks including warm-up, aerobic treadmill training, resistance exercises, respiratory exercises, therapeutic education. 24 4
Control Participants (n) Drop-outs (n)	Usual care/sedentary activity 12 2
Follow-up time points	Baseline (pre-CPRP) and post-CPRP (6 weeks); additional 2-week evaluation phase pre- and post-intervention.
Outcomes Measured	<u>Primary:</u> 6-minute walk distance (6MWD) <u>Secondary:</u> Dyspnoea (Borg, mMRC), spirometry (FEV1, FVC), heart rate (rest and end), SpO_2, 6-minute walk work (6MWW). MCID defined as 30 m for 6MWD and 1 point for mMRC
Results	<u>FEV1%, mean change from baseline (SD):</u> I: 7 (12) C: 1 (4) <u>6MWT, mean change from baseline (SD):</u> I: 168 (99) C: 5 (45)
Limitations Noted	Single-center; small sample size; short follow-up (6 weeks); no post-6MWT blood pressure or recovery SpO_2 measured; no bronchodilator tests; limited equipment (no plethysmography or diffusion capacity tests); no waist circumference data; results may not generalize to other populations.
Risk of bias	Moderate

Kerling et al. 2024

Author	Kerling et al.
Year	2024
Country	Germany
Study design	RCT
Setting	Outpatient care
Population	Volunteers ≥18 years (mean age 46.2 (SD 11.2) years, 67,7% women) with a continuing impairment of physical or mental health after COVID-19 (detection by polymerase chain reaction) infection with a fatigue assessment scale (FAS) score of 22 points.
Follow-up	After treatment (3 months)
Intervention Participants (n) Drop-outs (n)	Individually designed exercise plan recommending 150 min of moderate physical activity per week (60–75% of the maximum heart rate measured during the incremental exercise test). 35 5
Control Participants (n) Drop-outs (n)	Asked to continue with their current lifestyle and everyday activities 37 5
Outcomes and results	VO_2 peak, mean difference (95% CI) between groups: –0.6 (–1.8 to 0.8) Pulmonary function, FEV1 %, mean difference (95% CI) between groups: 1.69 (–2.00 to 5.39) Hospital anxiety and depression scale (HADS), mean (SD) post treatment: I: 6.0 (3.8) C: 8.0 (5.9) Quality of life, SF-36, mean difference (95% CI) between groups: 1.2 (–2.7 to 5.1) Quality of life, SF-36, mean difference (95% CI) between groups –3.0 (–8.5 to 2.5) Fatigue, FAS, mean difference (95% CI) between groups: 0.3 (–2.6 to 1.64)
Risk of bias	Moderate

Kogel et al. 2023

Author	Kogel et al. [14]
Year	2023
Country	Germany
Study design	RCT
Setting	Outpatient training program
Population	Participants, aged ≥18 years (mean age 42.7 (SD 13.4) years, 61% women) were recruited from a post covid clinic. Parti cants should have sustained fatigue (defined as >50 points with four or more dimensions affected on the MFI-20-questionnaire) at a minimum of 6 weeks after a COVID-19. The mean age was 42.7±13.4 years and 61% were females.
Follow-up	Follow-up after intervention (4 weeks) and after 3 and 6 months.
Intervention Participants (n) Drop-outs (n)	4 weeks of two to three times weekly personalized strength endurance training. 29 9 (at 6 months follow-up)
Control Participants (n) ' Drop-outs (n)	Care as usual, with no restrictions on exercise. 28 8 (at 6 month follow-up)
Outcomes and results	VO_2 peak, mean (SD) at post treatment: I: 29.1 (7.6) C: 25.2 (7.4) Fatigue, MFI-20 subscale general fatigue, mean (SD) post treatment: I: 12.4 (3.5) C: 12.9 (3.6)
Risk of bias	Moderate

Li et al. 2022

Author	Li et al. [15]
Year	2022
Country	China
Study design	RCT, multicenter
Setting	Home-based, outside health care setting
Population	Adults aged 18–75 years (55.5% female, mean age: 50.6 years) discharged after inpatient treatment for COVID-19 (68.1% not severe, 86.6% oxygen support or non-invasive ventilation), with a mMRC dyspnoea score of 2–3. Not completely fulfilling WHO criteria for post COVID-19 (long covid)
Follow-up	~28 weeks
Intervention Participants (n) Drop-outs (n)	Unsupervised home-based 6-week exercise programme comprising breathing control and thoracic expansion, aerobic exercise and LMS exercise, delivered via smartphone, and remotely monitored with heart rate telemetry. 59 23
Control Participants (n) Drop-outs (n)	Short education at baseline. 61 5
Outcomes and results	Physical function, 6MWT, mean difference (95% CI) between groups: 65.45 (43.8 to 87.1) Quality of life, SF-12 PCS, mean difference (95% CI) between groups: 3.79 (1.24 to 6.35) Quality of life, SF-12 MCS mean difference (95% CI) between groups 2.18 (–0.54 to 4.90)
Risk of bias	Moderate

Longobardi et al. 2023

Author	Longobardi et al. [16]
Year	2023
Country	Brazil
Study design	RCT, single-blind
Setting	Primary care/home-based
Population	Survivors (mean age 60.8±7.1 years (intervention) and 61.2±7.7 (control), 50% female) of severe/critical COVID-19 (5±1 months after intensive care unit discharge)
Follow-up	16 weeks post study start (end of treatment)
Intervention Participants (n) Drop-outs (n)	A home-based semi-supervised exercise training programme, 3 sessions a week for 16 weeks. 25 4
Control Participants (n) Drop-outs (n)	Standard of care including general advice for a healthy lifestyle 25 5
Outcomes and results	VO_2 peak, mean difference (95% CI) between groups: 1.57 (–2.71 to 5.86) Quality of life, SF-36 PCS, mean difference (95% CI) between groups: 16.8 (5.8 to 27.9) Fatigue, FSS, mean difference (95% CI) between groups: –1.08 (–2.47 to 0.30)
Risk of bias	Moderate

McGregor et al. 2023

Author	McGregor et al. [17]
Year	2023
Country	United Kingdom
Study design	Multicenter RCT
Setting	Home-based online-delivered intervention
Population	Adults (26–86 years, mean 56 years, 52% women) discharged from NHS hospitals at least three months previously after covid-19 and with ongoing physical and/or mental health sequelae, n=585
Follow-up	3, 6 and 12 months
Intervention Participants (n) Drop-outs (n)	Rehabilitation Exercise and psychological support (REGAIN) programme, consisting of weekly home based, live, supervised, group exercise and psychological support sessions (1 h each) delivered online for 8 weeks. 298 82
Comparison Participants (n) Drop-outs (n)	Usual care (a single online session of advice and support) 287 61
Outcomes and results	Hospital anxiety and depression scale, mean (SD) post treatment: I: 7.7 (4.5) C: 8.4 (4.8) Hospital anxiety and depression scale mean (SD) post treatment I: 8.0 (4.8) C: 8.6 (4.8) Health related quality of life, EQ-5D-5L, mean difference (95% CI) between groups 0.02 (-0.01 to 0.05) EQ VAS, mean difference (95% CI) between groups 3.37 (0.23 to 6.51)
Risk of bias	Måttlig

Rasmussen et al. 2023

Author	Rasmussen et al. [18]
Year	2023
Country	Denmark
Study design	Investigator blinded RCT
Setting	Outpatient
Population	Persons (mean age 57.2 (SD 10) years, 32% women) previously hospitalized for laboratory confirmed SARS-CoV-2, but no specific symptoms were required.
Follow-up	12 weeks
Intervention Participants (n) Drop-outs (n)	High-intensity interval training (HIIT) program with three 38 minutes supervised and individualized work out sessions including every week on bicycle ergometer with the aim to improve cardiorespiratory fitness 1 14 1
Control Participants (n) Drop-outs (n)	Standard care 14 1; 4 participants engaged in exercise program
Outcomes and results	VO_2 peak, mean difference (95% CI) between groups: 3.09 (–0.76 to 6.94) Pulmonary function, FEV1 %, mean difference (95% CI) between groups: –1.14 (–9.91 to 7.62)
Risk of bias	Moderate

Romanet et al. 2023

Author	Romanet et al. [19]
Year	2023
Country	France
Study design	Open assessor blinded multicenter RCT
Setting	Outpatient program setting
Population	Population (mean age 58 (SD 12) years, women 38%) with persistent respiratory symptoms after CARDS. Participants fulfilled WHO criteria for post COVID-19 (long covid)
Follow-up	12 weeks
Intervention Participants (n) Drop-outs (n)	Exercise training rehabilitation (ETR) including both endurance and strength training for pulmonary rehabilitation,2 x 60 minutes per week for 12 weeks. Power intensity was adjusted according to each participant's progress until the target heart rate and dyspnea were reached. 27 0 (4 chose standard physiotherapy during follow-up)
Control Participants (n) Drop-outs (n)	Standard usual care during the 90 days and received standard physiotherapy at the rate of 2 x 30 min sessions per week for 10 weeks. 33 0 (3 chose endurance training during follow-up)
Outcomes and results	Quality of life, SF-12 PCS mean difference (95% CI) between groups: 6.95 (2.62 to 11.29) Quality of life, SF-12 MCS mean difference (95% CI) between groups: 2.06 (–3.63 to 7.75)
Risk of bias	Moderate

Sharma & Vaish. 2024

Author	Sharma & Vaish. [20]
Year	2024
Country	India
Study Design	Randomised controlled trial
Setting	Outpatient Department of Physiotherapy, India
Population	38 participants with long COVID; age 25–60 years; both sexes
Inclusion criteria	RT-PCR confirmed COVID-19; age 25–60; long COVID symptoms ≥2 months; dyspnoea, fatigue or exertion symptoms
Exclusion criteria	Cardiovascular, neurological, diabetes, hypertension, recent trauma/surgery, pregnancy, respiratory/cognitive impairments
Intervention Participants (n) Dropouts (n)	Comprehensive rehabilitation (aerobic, strength, balance, flexibility, breathing, education) 6 weeks. 19 0
Control Participants (n) Dropouts (n)	Breathing exercises only 19 0
Follow-up time points	6 weeks
Outcomes measured	6MWT (functional capacity), Fatigue Severity Scale (FSS), EQ-5D-5L, EQ VAS (quality of life), dyspnoea
Results	6MWT mean change from baseline (SD): I: 66.28 (15.17) C: 14.02 (8.56) EQ-5D-5L, mean change from baseline (SD): I: 0.14 (0.13) C: 0.017 (0.079) EQ VAS, mean change from baseline (SD): I: 13.52 (5.46) C: 2.26 (2.2) FSS mean, (SD) post treatment: I: 21.31 (6.69) C: 30.63 (8.36)
Limitations Noted	Single centre; small sample size; no long-term follow-up; outcome assessor not blinded
Risk of bias	Moderate

Tryfonos et al. 2024

Author	Tryfonos et al. [21]
Year	2024
Country	Sweden
Study design	Randomised crossover clinical trial
Setting	Karolinska Institutet and Karolinska University Hospital, Stockholm, Sweden
Population	31 patients with post-COVID condition (PCC) and 31 age- and sex-matched healthy controls. Mean age PCC: 46.6 years; controls: 47.3 years. 77% women in PCC group. Participants had verified SARS-CoV-2 infection and persistent symptoms consistent with PCC. Duration of symptoms: not reported clearly.
Inclusion Criteria	Adults with verified SARS-CoV-2 infection and post-COVID condition symptoms; age- and sex-matched healthy controls
Exclusion Criteria	Not reported clearly in the main article text
Intervention Participants (n) Dropouts (n)	3 exercise interventions with 2–4-week washout between sessions: (1) High-intensity interval training (HIIT) (2) Moderate-intensity continuous training (MICT) (3) Strength training (ST) At start: n=30 patients with PCC I 1: n=30 I 2: n=27 I 3: n=26 I 1: n=0 I 2: n=3 I 3: n=4
Control Participants (n) Dropouts (n)	Usual care according to long COVID clinical guidelines without additional research contact At start: n=31 usual care I 1: n=31 I 2: n=30 I 3: n=29 I 1: n=0 I 2: n=1 I 3: n=2
Follow-up Timepoints	Pre-exercise baseline, immediately post-exercise, and 48 hours after each exercise session
Outcomes measured	<u>Primary outcome:</u> Changes in fatigue symptoms (between-group differences) from baseline to 48 hours after exercise, assessed via the visual analog scale(VAS). Several additional outcomes were reported.
Results	Patients with PCC reported more symptoms than controls at all timepoints. However, there was no difference between the groups in the worsening of fatigue in response to the different exercises <u>Fatigue, mean (SD) VAS ranks at 48 hrs:</u> **HIIT** PCC: 29.3 (19.5) C: 28.7 (11.4) *p=0.08*

	MICT PCC: 31.2 (17.0) C: 24.6 (11.7) *p=0.09* ST PCC: 31.0 (19.79) C: 28.1 (12.2) *p=0.49*
Limitations	Small sample size; exercise responses may not generalize to all PCC populations; heterogeneity in PCC manifestations; short-term follow-up only; some inclusion/exclusion details not fully described in the main article.
Risk of bias	Moderate

Volckaerts et al. 2025

Author	Volckaerts et al. [22]
Year	2025
Country	Belgium
Study design	Prospective, pragmatic, two-centre, parallel-group randomised controlled trial
Setting	Two hospitals in Belgium (Antwerp University Hospital and Ziekenhuis Oost-Limburg) with rehabilitation delivered by primary care physiotherapists
Population	Adults ≥18 years with confirmed COVID-19 infection more than 6 weeks earlier and persistent long-COVID symptoms (fatigue, dyspnoea, or reduced functional status)
Inclusion Criteria	Confirmed COVID-19 infection >6 weeks earlier and persistent symptoms defined by CAT ≥10, mMRC≥2, CIS-fatigue≥36, or PCFS ≥2
Exclusion Criteria	Cognitive, hearing, visual, neurological or musculoskeletal conditions; had more than eight physiotherapy sessions due to long COVID complaints, and any in the past 12 weeks before randomisation; neurological disorders that impact respiratory function; organ transplantation in the past or near future; active malignancy or (maintenance) treatment for active malignancy or curatively treated malignancy within the past year
Intervention Participants (n) Drop-outs (n)	Pulmonary Rehabilitation (PR): 12-week stepwise pulmonary rehabilitation programme in primary care with 36 individual physiotherapy sessions (3 sessions/week, ~30 min), including education, endurance training, strength training, breathing exercises, inspiratory muscle training, lifestyle coaching. 39 7
Control Participants (n) Drop-outs (n)	Usual care with no pulmonary rehabilitation during the intervention period 37 6
Follow-up Timepoints	Assessments at baseline, 6 weeks, 12 weeks (end of intervention), 24 weeks, and questionnaires at 36 weeks
Primary Outcome	Change in functional exercise capacity measured by the 6-minute walk distance (6MWD) from baseline to 12 weeks
Secondary Outcomes	CIS fatigue score, CAT, EQ 5D 5L quality of life, daily step counts (accelerometer), maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP), handgrip strength, Nijmegen questionnaire, Hospital Anxiety and Depression Scale (HADS), and dyspnoea (mMRC).
Results	At 12 weeks: 6MWT, mean difference (95% CI) between groups 38.81 (18.17 to 59.45)
Limitations Noted	Modest sample size, which reduces precision and reproducibility of the findings; indication of limited sensitivity of the EQ-5D-5L to capture long COVID-specific burden; individuals with a high symptom burden or experiencing PEM likely chose not to participate due to concerns about the intensive

	nature of the programme; no validated questionnaire was used to screen for PEM. Note that results are adjusted for covariates, several models are available.
Risk of bias	Moderate

Abbreviations:

ADL	Activities of daily living
AE	Aerobic exercise
AE/RE	Aerobic exercise/Resistence Exercise
AT	Anaerobic threshold
BMI	Body mass index
BPI	Brief Pain Inventory
C	Control (group)
CARDS	COVID-19-associated acute respiratory distress syndrome
CAT	COPD Assessment Test
CI	Confidence interval
CIS-fatigue	Fatigue severity subscale of the Checklist Individual Strength
COPD	Chronic obstructive pulmonary disease
CPET	Cardiopulmonary exercise test
CPRP	Cardiopulmonary rehabilitation programme
CT	Computed tomography scan
DBE	Diaphragmatic breathing exercise
EQ-5D-5L	EuroQol 5-Dimension 5-Level (quality of life questionnaire)
EQ VAS	EuroQol Visual Analogue Scale
FACIT-FS	Functional Assessment of Chronic Illness Therapy - Fatigue Scale
FAS	Fatigue Assessment Scale
FEV1	Forced expiratory volume in the first second
FSS	Fatigue severity scale
FVC	Forced vital capacity
GAD-7	Generalised Anxiety Disorder 7-item scale
GDS	Geriatric Depression Scale
h	Hour(s)
HADS	Hospital Anxiety and Depression Scale
HR	Heart rate
HRmax	Maximum heart rate
HRQoL	Health-related quality of life
hrs	Hours
I	Intervention (group)
ICU	Intensive care unit
IQR	The Interquartile Range
ISI	Insomnia Severity Index
ISWT	Incremental Shuttle Walk Test
ITT	Intention-to-treat (analysis)
MCID	Minimal clinically important difference
MCS	Mental Component Summary score of Short Form-36 Health Survey (SF-36)
MFI-20	Multidimensional Fatigue Inventory Scale
MoCA	Montreal Cognitive Assessment

MRC	Medical Research Council
mMRC	Modified Medical Research Council (dyspnoea scale)
n	number
NYHA	New York Heart Association (heart failure classification)
PC19-PF	Post-COVID-19 Pulmonary Fibrosis
PCFS	Post-COVID Functional Scale
PCR	Polymerase chain reaction
PCS	Physical Component Score/Scale with SF-12, SF-36; also Post-COVID-19 syndrome
PEM	Post-exertional malaise
PESE	Post-Exertional Symptom Exacerbation
PHQ	Patient Health Questionnaire-
POTS	Postural orthostatic tachycardia syndrome
PSS	Perceived Stress Scale
RCT	Randomised controlled trial
RE	Resistence exercise
SD	Standard deviation
SF-12	Short Form-12 Health Survey
SF-36	Short Form-36 Health Survey (quality of life questionnaire)
SpO_2	Oxygen saturation (peripheral)
SPPB	Short Physical Performance Battery
VAS	Visual Analogue Scale
VCO_2	Carbon dioxide output
VE	Ventilation
VO_2	Oxygen consumption (volume of oxygen)
WHO	World Health Organization
WHO-CPS	The World Health Organization Clinical Progression Scale
1RM	One-Repetition Maximum
6MWD	6-Minute Walk Distance
6MWT	6-Minute Walk Test
6MWW	6-Minute Walk Work

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