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Exercise as a key driver of physical fitness in lung cancer: a systematic review and meta-analysis

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Background



Patients enter the cancer pathway already vulnerable

- At diagnosis, patients with lung cancer often show reduced cardiorespiratory fitness (CRF), impaired muscle strength, and muscle wasting.
- Surgery, systemic treatments, symptoms, and physical inactivity may further accelerate this decline.



Physical fitness is clinically relevant across the lung cancer continuum

- CRF, muscle strength, and lean body mass are strong prognostic factors, associated with postoperative complications, recurrence, treatment response, and survival.



Exercise is a key modulator

- Exercise can improve CRF, muscle strength, and body composition in people with cancer.
- It remains unclear whether benefits are consistent across different clinical and exercise characteristics.

Aims of the study

1

To quantify the effects of exercise interventions on CRF, muscle strength, and lean body mass in patients with lung cancer

2

To explore whether these effects vary according to disease stage, treatment status, clinical setting, and exercise characteristics

Search strategy

Systematic search on: PubMed/MEDLINE, Scopus, Web of Science, CINAHL, and Cochrane Central Register of Controlled Trials; + backward citation tracking performed by screening the reference lists; **Search period:** April 30, 2026; Registered on **PROSPERO**: CRD420251156033

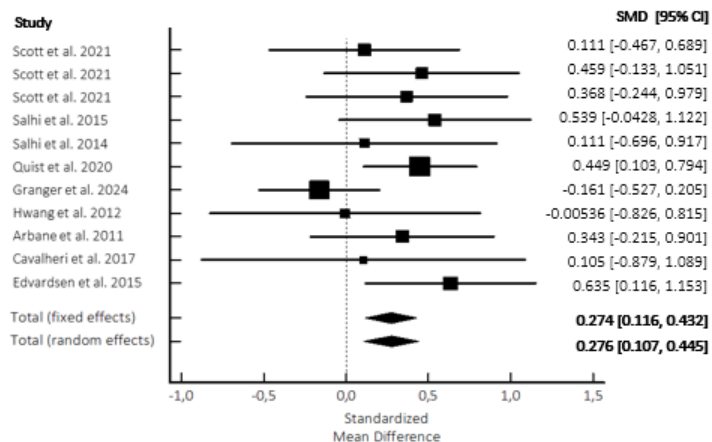
Eligibility criteria

Population	Adults (≥ 18 y), with lung cancer, stage I–IV, across the entire treatment continuum
Intervention	Exercise interventions lasting ≥ 2 weeks
Comparator	Non-exercise control (usual care, placebo intervention)
Outcomes	CRF (VO_2 peak, 6MWT), upper/lower strength (1RM, handgrip, isokinetic), lean body mass (CT, DEXA, BIA)
Study design	Randomized controlled trials (individually randomized, cluster, crossover)

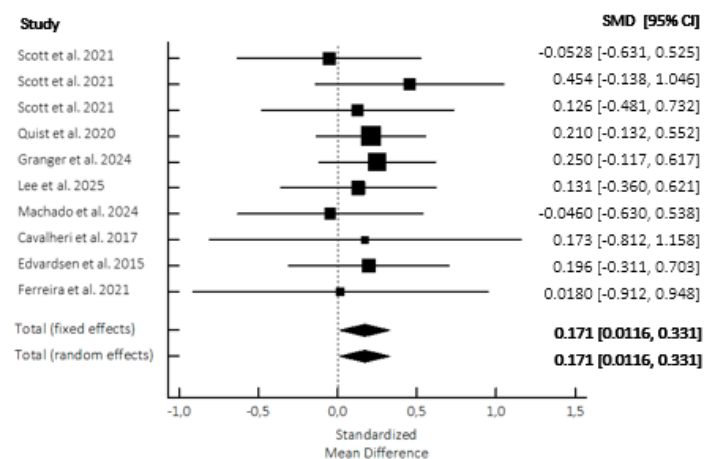
Analysis

- Random-effects models using standardized mean differences (SMDs) with 95% CIs
- Subgroup analyses by disease stage, treatment status, clinical setting, exercise modality and intervention duration
- Meta-regression exploring participant- and exercise-related moderators
- Risk of bias: RoB 2 | Certainty of evidence: **GRADE**

Results Of the initial 5,322 records, 27 RCTs were considered eligible for the meta-analysis. Five studies were judged at low risk of bias, 7 raised some concerns, and 15 were considered at high risk of bias.



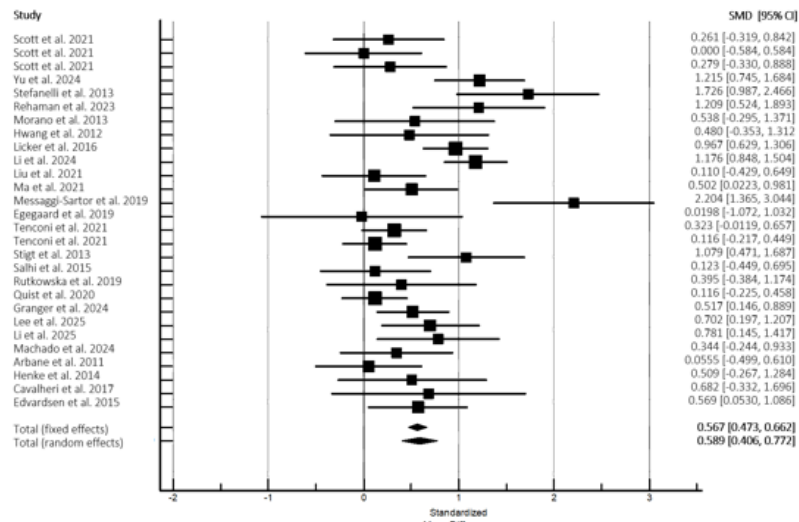
**GRADE:
Moderate**



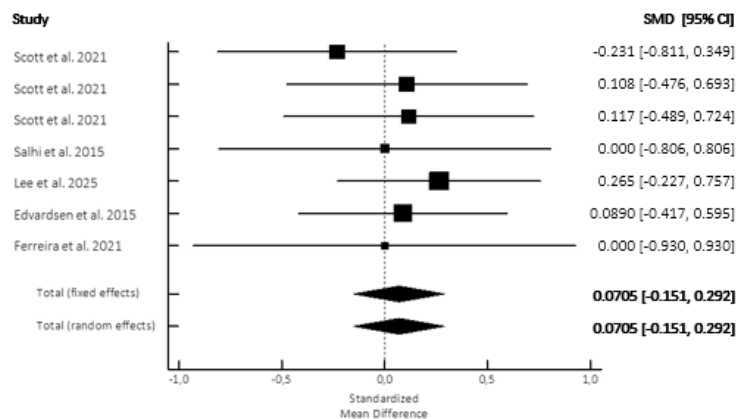
**GRADE:
Low**

Treatment modifier	N. studies	SMD
Cancer setting		
Prehabilitation	2	0.03(-0.51, 0.46)
Rehabilitation	3	0.23 (-0.05, 0.50)
Palliative	2	0.18(-0.09, 0.46)
Treatment status		
Off	6	0.11 (-0.15, 0.37)
Mixed	3	0.20 (-0.05, 0.45)
Stage		
Early	8	0.16 (-0.03, 0.36)
Advanced	2	0.18(-0.09, 0.46)
Exercise modality		
Combined	8	0.17 (-0.01 0.34)
Exercise length		
≤7 weeks	3	0.05 (-0.29, 0.39)
>7 weeks	7	0.21 (0.02, 0.38)
Cancer setting		
Rehabilitation	6	0.15 (-0.05, 0.55)
Palliative	2	0.36 (0.06, 0.69)
Treatment status		
Ongoing	2	0.47 (0.18, 0.77)
Off	6	0.28 (0.02, 0.53)
Mixed	3	0.15 (-0.39, 0.70)
Stage		
Early	9	0.25 (-0.05, 0.46)
Advanced	2	0.36 (0.06, 0.69)
Exercise modality		
Aerobic	2	0.07 (-0.39, 0.53)
Resistance	2	0.33 (-0.13, 0.80)
Combined	7	0.32 (0.07 0.56)
Exercise length		
>7 weeks	11	0.28 (0.11, 0.44)

CRF

GRADE:
Moderate

Treatment modifier	N. studies	SMD
Cancer setting		
Prehabilitation	7	0.70 (0.33, 1.07)
Rehabilitation	13	0.72 (0.42, 1.03)
Palliative	6	0.33 (0.10, 0.60)
Treatment status		
Ongoing	6	0.37 (0.02, 0.72)
Off	16	0.61 (0.33, 0.89)
Mixed	6	0.74 (0.55, 0.94)
Stage		
Early	20	0.59 (0.37, 0.81)
Advanced	6	0.33 (0.10, 0.60)
Exercise modality		
Aerobic	12	0.87 (0.55, 1.18)
Combined	15	0.38 (0.24, 0.53)
Exercise length		
≤7 weeks	12	0.68 (0.41, 0.94)
>7 weeks	16	0.53 (0.27, 0.78)
Cancer setting		
Rehabilitation	2	0.06 (-0.36, 0.48)
Treatment status		
Off	5	0.04 (-0.29, 0.28)
Mixed	3	0.15 (-0.39, 0.70)
Stage		
Early	6	0.02 (-0.23, 0.27)
Exercise modality		
Resistance	2	0.07 (-0.39, 0.53)
Combined	4	0.15 (-0.14, 0.43)
Exercise length		
≤7 weeks	2	0.20 (-0.23, 0.63)

Lean body
massGRADE:
Low

Meta-regression

- **Age, BMI, intervention length, resistance-training frequency, and aerobic-session duration:** no significant associations with any outcome.
- Higher **aerobic training frequency** was associated with greater improvements in **lower-limb strength**

Limitations

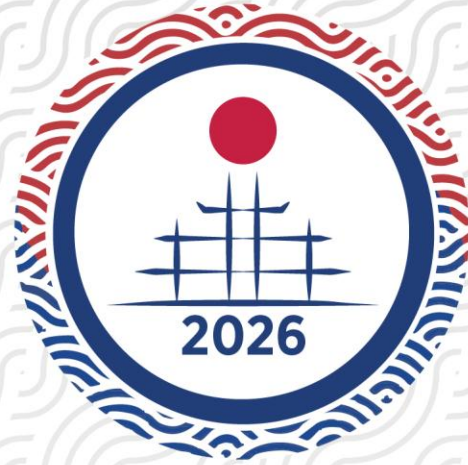
- Substantial heterogeneity in exercise prescription across studies.
- Incomplete reporting of intensity, progression, supervision, adherence, and safety.
- Limited evidence for lean body mass and inconsistent reporting of oncological and nutritional factors.

Strength

- Most comprehensive meta-analysis to date specifically evaluating CRF, muscle strength, and lean body mass in lung cancer.
- Inclusion of subgroup analyses, meta-regression, RoB 2, and GRADE strengthened the interpretation of clinical and exercise-related modifiers

Clinical implications & take-home messages

- Exercise improves CRF and muscle strength across different stages, treatment statuses, and clinical settings.
- Improving lean body mass may require more targeted progressive resistance training plus nutritional support and multimodal strategies.
- Exercise should be integrated across the lung cancer continuum - with prescription increasingly tailored to the clinical setting, treatment phase, and target outcome.



Thank You.