XII Meeting. State of the Art in
HEART FAILURE
CLINICAL PRACTICE AND ORGANIZATIONAL MODELS

XII Reunión. Estado del Arte en
INSUFICIENCIA CARDIACA
PRÁCTICA CLÍNICA Y MODELOS ORGANIZATIVOS

A Coruña
Heart Failure
Academy

Exercise Training in Heart Failure: How and to Whom

September 26th, 2025

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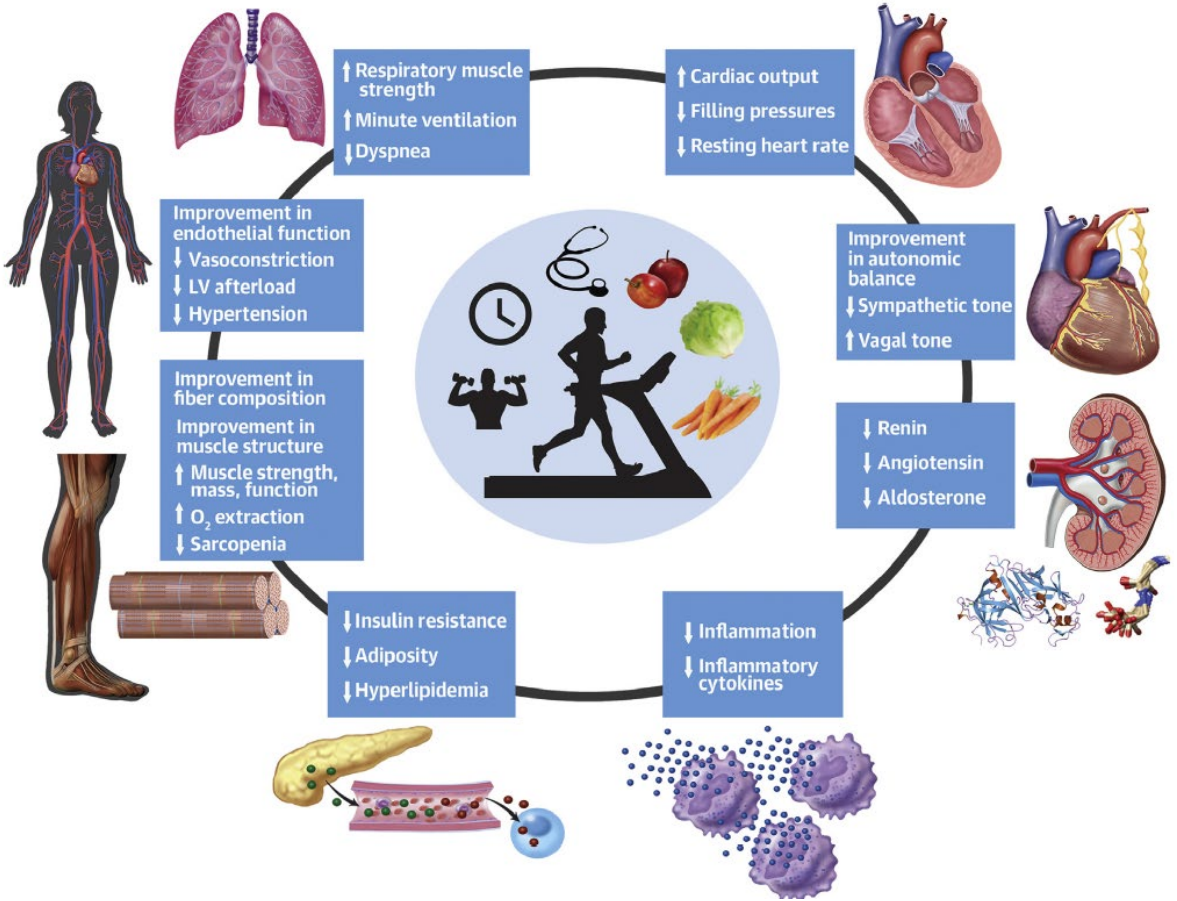
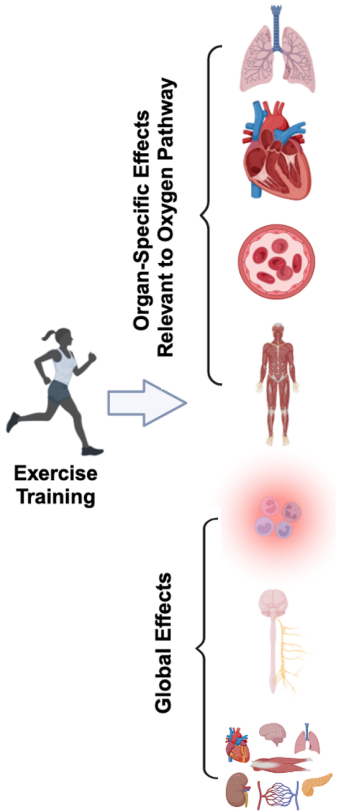
Universitari de València

Cardiac rehabilitation in Heart Failure



Bozkurt B, et al J Am Coll Cardiol. 2021 Mar 23;77(11):1454-1469

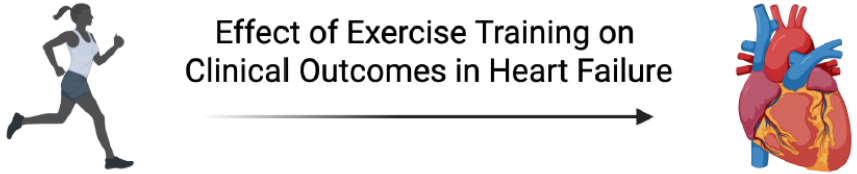
Exercise Training in Heart Failure



Organ System	Physiologic Effects of Exercise Training	Potential Molecular Mechanisms
Respiratory System	Peak and reserve VO_2 ⬆ V_E/VCO_2 slope ⬇ Inspiratory muscle strength ⬆ Diffusion capacity & pulmonary blood flow ⬆	Diaphragm contractile dysfunction ⬇ with less oxidative modification of actin and creatine kinase, ⬇ proteolytic pathways
Cardiac Structure and Function	LV size ⬇ Systolic function improved (LVEF, SV, CO) ⬆ Diastolic function improved (E/e', IVRT) ⬆	Myocardial stiffness ⬇ with increased titin compliance (via PEVK domain phosphorylation)
Systemic Vasculature	Rest and peak systemic vascular resistance ⬇ Endothelial function ⬆	Endothelial vasodilation ⬆ via ⬆ eNOS, NO pathways, expansion of endothelial progenitor cells
Skeletal Muscle	Muscle atrophy ⬇ Oxidative stress ⬇ Mitochondrial content ⬆	⬆ Oxidative (type I) and ⬇ glycolytic (type II) fibers, enhanced mitochondrial activity and biogenesis, ⬆ angiogenesis in skeletal muscle
Global effects	**Physiologic Effects of Exercise Training**	**Potential Molecular Mechanisms**
Inflammation, oxidative stress	Anti-inflammatory & anti-oxidant effects Skeletal myopathy ⬇ Endothelial function ⬆	⬇ Pro-inflammatory cytokines including TNF-α , IL-6 and soluble IL-6 receptor ⬆ Radical scavenger enzymes (glutathione peroxidase, catalase)
Autonomic nervous system & neurohormones	Sympathetic activity ⬇ Arterial baroreflex sensitivity ⬆ Muscle metaboreflex ⬇ and mechanoreflex ⬆	Balance ACE and ACE2 Norepinephrine, vasopressin, angiotensin II, aldosterone ⬇ ⬇ COX-2 expression and ⬇ NFκB/IκB ratio
Multi-Organ Crosstalk	*Extrapolated from healthy populations:* Inter-organ communication ⬆ with diverse effects on molecular pathways involved in inflammation, fatty acid metabolism, endothelial function, among others	Release of exerkines ⬆ Release of extracellular vesicles ⬆

Mounsey LA, et al. Circ Res. 2025 Jul 7;137(2):273-289

Exercise Training in Heart Failure



	Clinical Events	Exercise Capacity	Quality of Life
HFrEF	↔ Mortality ↓ Mortality (adjusted for prognostic factors*) ↓ Hospitalization (adjusted for prognostic factors* and in meta-analyses)	↑ Peak VO_2	↑ Mood ↑ QOL in short term ↔ QOL in long term
HFpEF	↔ Mortality ↔ Hospitalization ↓ Hospitalization (in meta-analyses)	↑ Peak VO_2	↑ Mood ↑ QOL in short term

Mounsey LA, et al. Circ Res. 2025 Jul 7;137(2):273-289

Exercise Training in Heart Failure

Cochrane Library

Cochrane Database of Systemati

Exercise-ba itation for adults with heart failure (Revie

rdi IR, Bridges C, Sagar VA, Davies EJ, Coats AJS, Dalal H, Rees K, Singh SJ,

HFpEF under-represented

Molloy C, et al. **Cochrane Database Syst Rev. 2024** Mar 7;3(3):CD003331

To whom?

Stable ambulatory patients

Recommendations	Class[a]	Level[b]
Exercise is recommended for all patients who are able in order to improve exercise capacity, QOL, and reduce HF hospitalization.[c] 324–328,335–337	I	A

Physical Rehabilitation for Older Patients Hospitalized for Heart Failure

Dalane W. Kitzman, M.D., David J. Whellan, M.D., M.H.S., Pamela Duncan, P.T., Ph.D., Amy M. Pastva, P.T., Ph.D., Robert J. Mentz, M.D., Gordon R. Reeves, M.D., M.P.T., M. Benjamin Nelson, M.S., Haiying Chen, Ph.D., Bharathi Upadhya, M.D., Shelby D. Reed, Ph.D., Mark A. Espeland, Ph.D., LeighAnn Hewston, D.P.T., M.Ed., and Christopher M. O'Connor, M.D.

N Engl J Med. 2021;385:203-216

Early after admission

Frailty and Effects of a Multidomain Physical Rehabilitation Intervention Among Older Patients Hospitalized for Acute Heart Failure
A Secondary Analysis of a Randomized Clinical Trial

Ambarish Pandey, MD, MSCS[1]; Dalane W. Kitzman, MD[2,3]; M. Benjamin Nelson, MS[2] ; et al

JAMA Cardiol. 2023;8 :167–176.

Frail patients

Recommendations	Class[a]	Level[b]
A supervised, exercise-based, cardiac rehabilitation programme should be considered in patients with more severe disease, frailty, or with comorbidities.[95,324–327,338]	IIa	C

Advanced HF

PLOS ONE

RESEARCH ARTICLE

Short- and long-term effects of a cardiac rehabilitation program in patients implanted with a left ventricular assist device

Anna Scaglione[1], Claudia Panzarino[1], Maddalena Modica[1], Monica Tavanelli[1], Antonio Pezzano[1], Paola Grati[1], Vittorio Racca[1], Anastasia Toccafondi[1], Bruno Bordoni[1], Alessandro Verde[2], Iside Cartella[2], Paolo Castiglioni[1]*

PLoS One. 2021 ;16:e0259927

McDonagh TA, et al. Eur Heart J. 2021 Sep 21;42(36):3599-3726

To whom (not)?

Cardiac	Non cardiac
ACS (within 2 days)	Acute systemic illness, fever
Untreated potentially life-threatening arrhythmias	Uncontrolled diabetes mellitus or thyroid dysfunction
Acute decompensated HF	Severe COPD
High-grade AV block	Severe cerebrovascular or musculoskeletal disorders that preclude exercise testing or training
Acute phase of myocarditis or pericarditis	
Severe symptomatic aortic stenosis	
Symptomatic obstructive hypertrophic cardiomyopathy	
Intracardiac thrombus	
NYHA Class IV	
Myocardial ischemia at low workload	

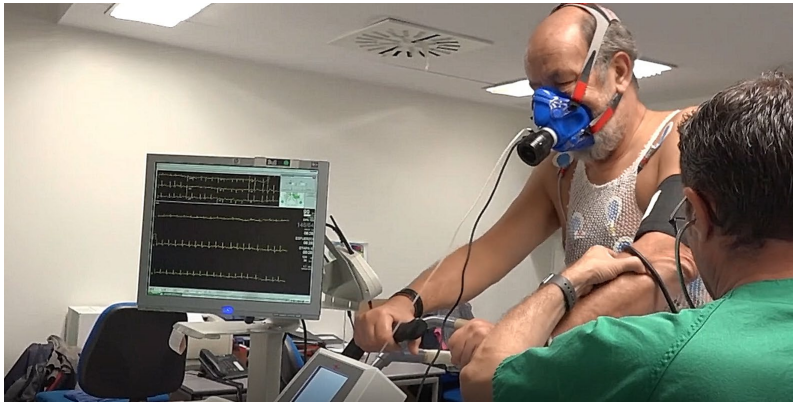
Piepoli MF, et al. Eur J Heart Fail. 2011;13(:347-57.

How?

CPET

Cardiopulmonary exercise testing should be considered to optimize prescription of exercise training.[94–96]	IIa	C

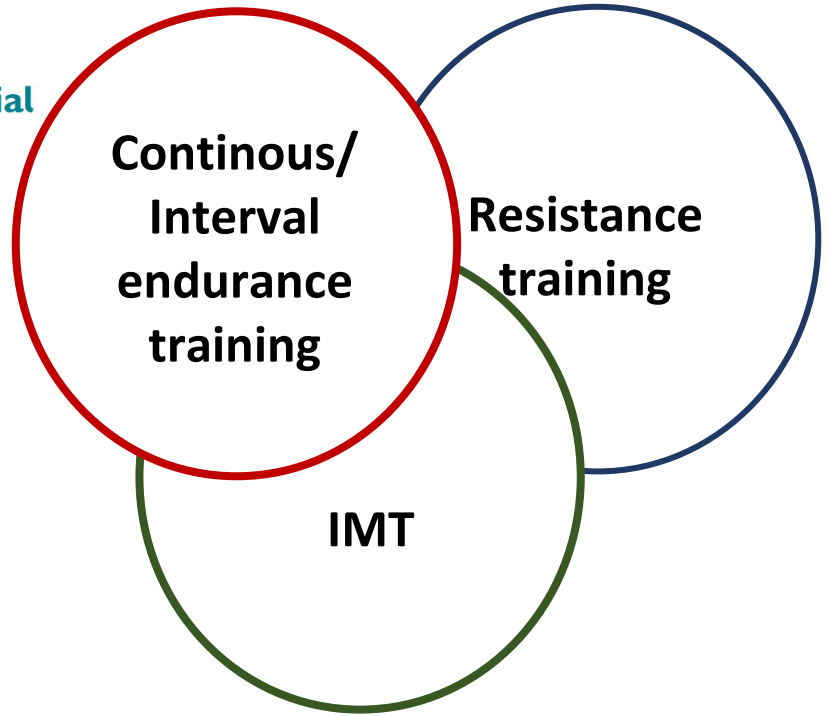
- ✓ Risk stratification and prognosis
- ✓ Physiopathological mechanisms
- ✓ Determine training intensity
- ✓ Re-test after exercise training



Ponikowski P, et al. Eur Heart J. 2016;37:2129-200

How?

Combined aerobic/resistance/inspiratory muscle training as the 'optimum' exercise programme for patients with chronic heart failure: ARISTOS-HF randomized clinical trial



Laoutaris et al. Eur J Preventive Cardiol. 2020

How?

- ✓Frequency
- ✓Intensity
- ✓Time
- ✓Type

TABLE 4 Frequency, Intensity, Time, and Type of Exercise Regimen Commonly Used for Patients With Heart Failure in Cardiac Rehabilitation

	Aerobic Exercise	Resistance Exercise
Frequency	5 days/week, moderate intensity* 3 days/week, high intensity†	2 or 3 nonconsecutive days/week
Intensity	Exercise in target heart rate Focus on a variety of intensities	Determined by the amount of weight lifted and the repetitions and sets Goal of 8–10 exercises, about 1–3 sets of 8–16 repetitions of each exercise
Time	30–60 min/session; shorter if exercise is high intensity	Depends on strength and schedule: up to 1 h for total body workout, less for split-routine workout
Type	Any activity that increases heart rate, such as running, walking, cycling, or dancing	Activities using resistance: bands, dumbbells, machines, body weight exercise

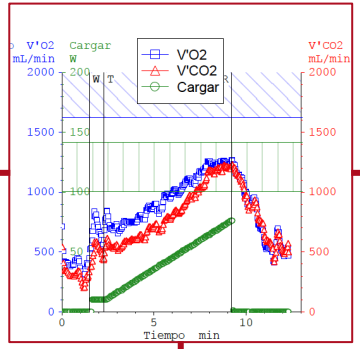
Modified with permission from Josephson and Mehanna (93). *Moderate intensity: 50% to 69% of target heart rate. †High intensity: 70% to <90% of target heart rate.

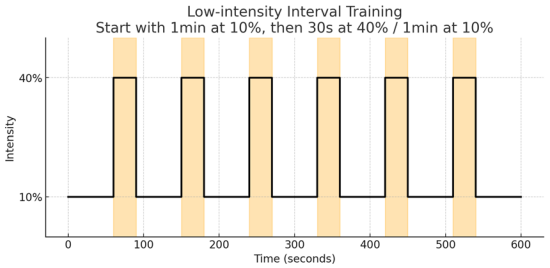
Bozkurt B, et al J Am Coll Cardiol. 2021 Mar 23;77(11):1454-1469

Endurance training

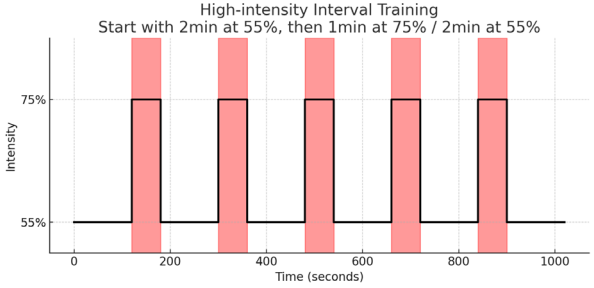
pp-picoVO2 >80%

- ✓ **Interval training** (or continuos)
- ✓ High intensity (70-85%) (RPE 14-16). Moderate intensity recovery (55 %)
- ✓ Increase time and intensity (progress)



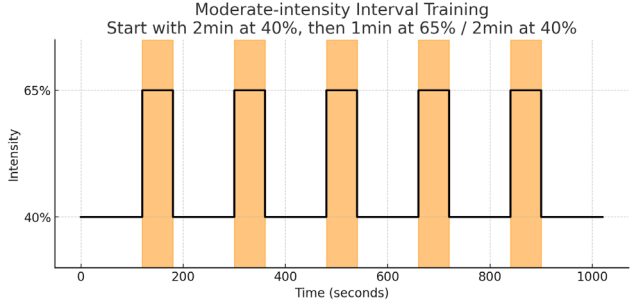


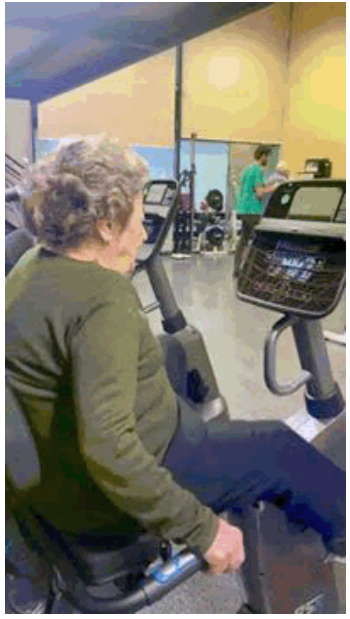
- ✓ **Inter**
- ✓ Low intensity (30-40%) short duration (RPE 10-11). Very low intensity recovery (10%)
- ✓ Increase time and intensity (progress)



pp-picoVO2 60-80%

- ✓ **Interval training** (or continuos)
- ✓ Moderate inte
  13). Low inter
- ✓ Increase time

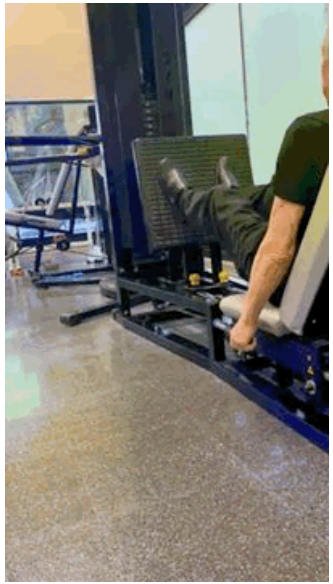




Pelliccia A, et al. ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease. Eur Heart J. 2021;42:17-96

Resistance training

Parameter	Duration	Intensity	Frequency	Progression
Muscular mass	*10-15 repetitions per set *1-3 set of **8 differents upper and lower muscle groups**	*Borg RPE <15 *40-60% of 1-RM	2-3 days per week	Increase progressively number of sets and resistance



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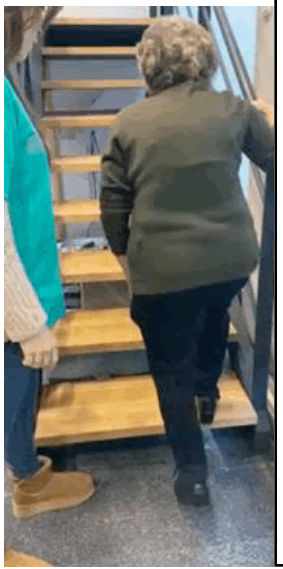
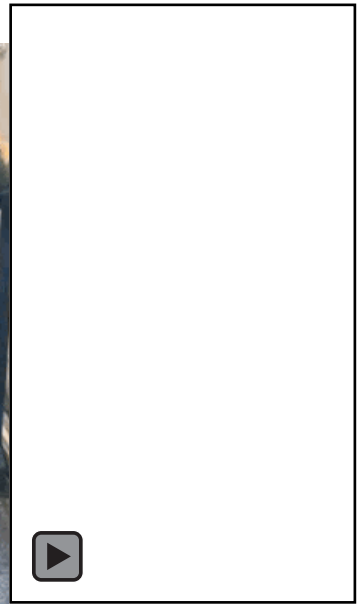
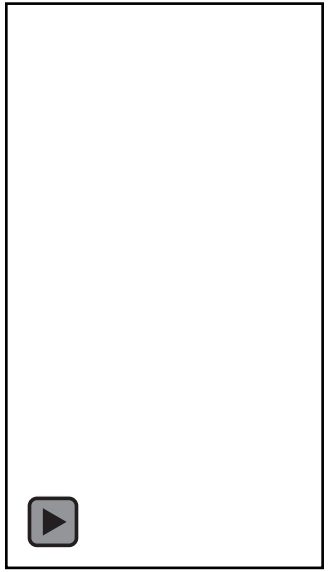
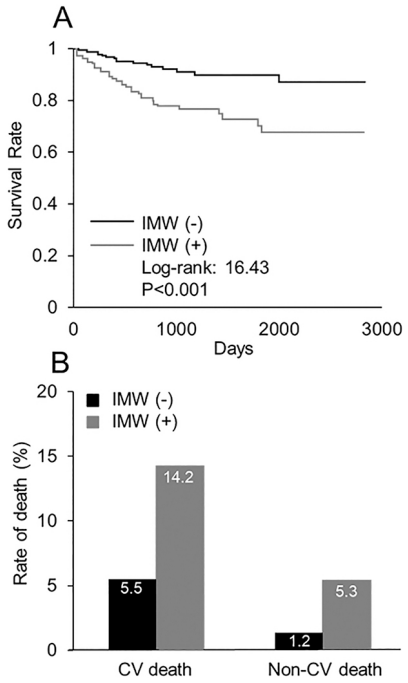





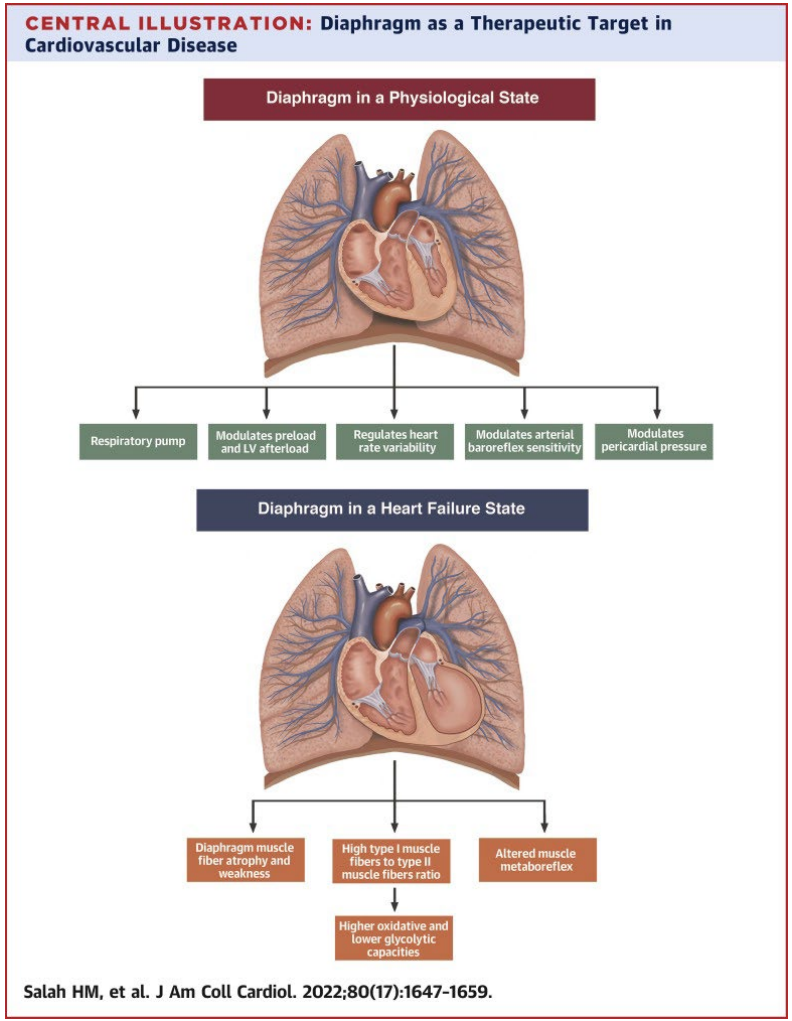

Resistance training

Palau et al. Rev Esp Cardiol (Engl Ed). 2019;72:288-297.
Karavidas et al. Heart Fail Rev. 2010;15:563-79

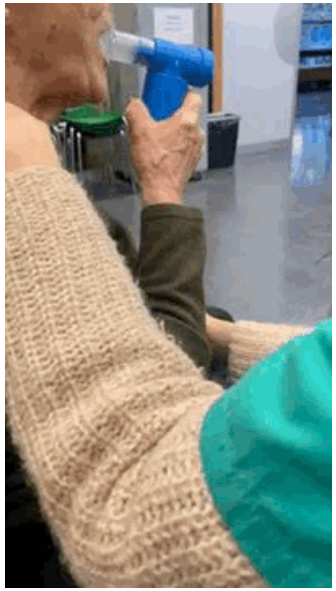
Inspiratory muscle training

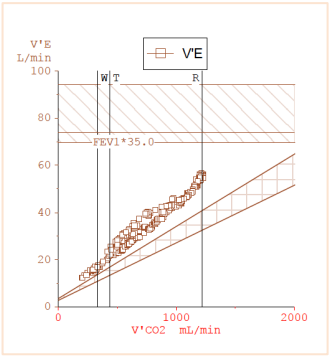


Smith JR. Inspiratory muscle weakness in cardiovascular diseases: Implications for cardiac rehabilitation. Prog Cardiovasc Dis. 2022;70:49-57.



Inspiratory muscle training





Parameter	Duration	Intensity	Frequency	Progression
Ventilatory efficiency	*Repetitions: 6-8/min *Duration: 10–15 min/twice daily	*30–60% of PImax	2 sessions/day	Increase resistance and duration

Conclusion

- ✓In HFrEF, exercise training significantly improves **functional capacity, quality of life, and clinical outcomes.**
- ✓In HFpEF, exercise training improves **functional capacity and quality of life**, but we still need clinical trials assessing hard clinical outcomes.
- ✓Exercise prescription should be **individualized.**
- ✓In Spain, **fewer than 10% of patients with heart failure** have access to cardiac rehabilitation.
- ✓So, **let's prescribe it!**

Exercise is not just an option, it is a treatment for patients with heart failure