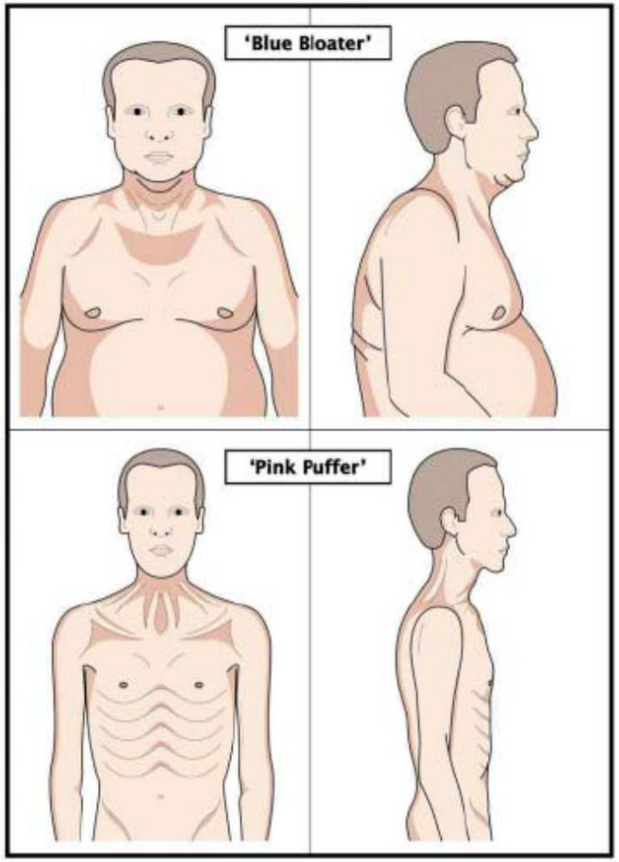
*Journal club del Venerdì*

# LA RIABILITAZIONE DEL PAZIENTE BRONCOPNEUMOPATICO

Fabio Guerini

***Brescia, 4 Novembre 2016***




The clinical heterogeneity of COPD: a typical "blue bloater" (top) and "pink puffer" (bottom)

UNIVERSITÀ DEGLI STUDI DI BRESCIA
FACOLTÀ DI MEDICINA E CHIRURGIA

TESI DI LAUREA

# FATTORI PREDITTIVI DI MORTALITÀ IN PAZIENTI ANZIANI AFFETTI DA BPCO: RUOLO DELLA COMORBILITÀ

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Highlights

- Pulmonary rehabilitation (PR)
- Principi fisiopatologici
- Quali benefici
- Training (endurance vs resistenza; indicazioni operative pratiche; protocolli di adattamento)
- La valutazione degli outcome
- PR and Physical Activity

Epidemiologia

COPD currently ranks **fourth** as a cause of **death** in the United States and is on course to be the third most common cause of death worldwide by 2020.

Whereas COPD was once principally a disease of men, it now kills roughly equal numbers of **men and women** in the United States.

In 2000, COPD was responsible for 8 million physician office visits, 1.5 million **emergency** department visits, and 726,000 **hospitalizations** (about 13% of total hospitalizations)

It is **second** only to coronary heart disease as a reason for **payment** of Social Security disability benefits.

N Engl J Med 2009;360:1329-35.

# Epidemiologia

## AMERICAN THORACIC SOCIETY DOCUMENTS

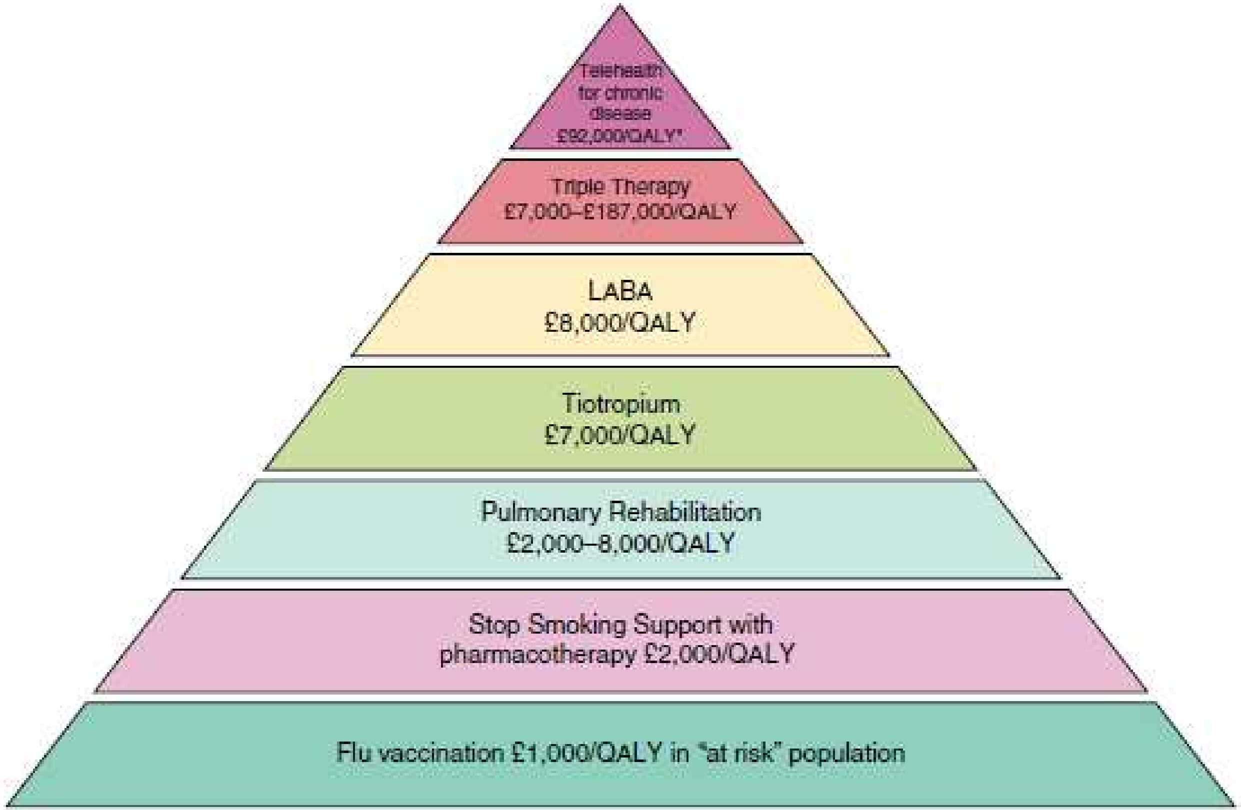


**Figure 1.** Cost-effectiveness of pulmonary rehabilitation relative to other treatments for chronic obstructive pulmonary disease. Reprinted from Reference 96. *Cost per quality-adjusted life year (QALY). LABA = long-acting β-agonist.

Am J Respir Crit Care Med Vol 192, Iss 11, pp 1373–1386, Dec 1, 2015

Fisiopatologia

Chronic obstructive pulmonary disease (COPD) is an irreversible condition, characterized by airflow limitation and chronic inflammation of the airways.

The clinical profile includes dyspnea, fatigue, reduced exercise tolerance, and diminished physical activity (PA), contributing to a poorer health-related quality of life (HRQOL)

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Fisiopatologia

Although COPD primarily affects lung function, it often has extrapulmonary manifestations.

Principal among these systemic manifestations is skeletal-muscle dysfunction, especially in the leg muscles involved with ambulation.

N Engl J Med 2009;360:1329-35.

Fisiopatologia

## Examination of leg-muscle tissue:

- decreased aerobic enzyme activity
- low fraction of type I (aerobic) fibers,
- decreased capillarity
- Presence of inflammatory cells, and increased apoptosis

## Reduced aerobic capacity, with early onset of lactic acidosis

N Engl J Med 2009;360:1329-35.

Fisiopatologia

Muscle fatigue occurs at work rates that would not engender fatigue in healthy subjects.

It has been shown that in an appreciable fraction of patients with COPD, muscle fatigue rather than dyspnea is the primary factor limiting exercise tolerance.

It is likely that the primary cause of these muscle abnormalities is **deconditioning** (patients with COPD are often very sedentary)

N Engl J Med 2009;360:1329-35.

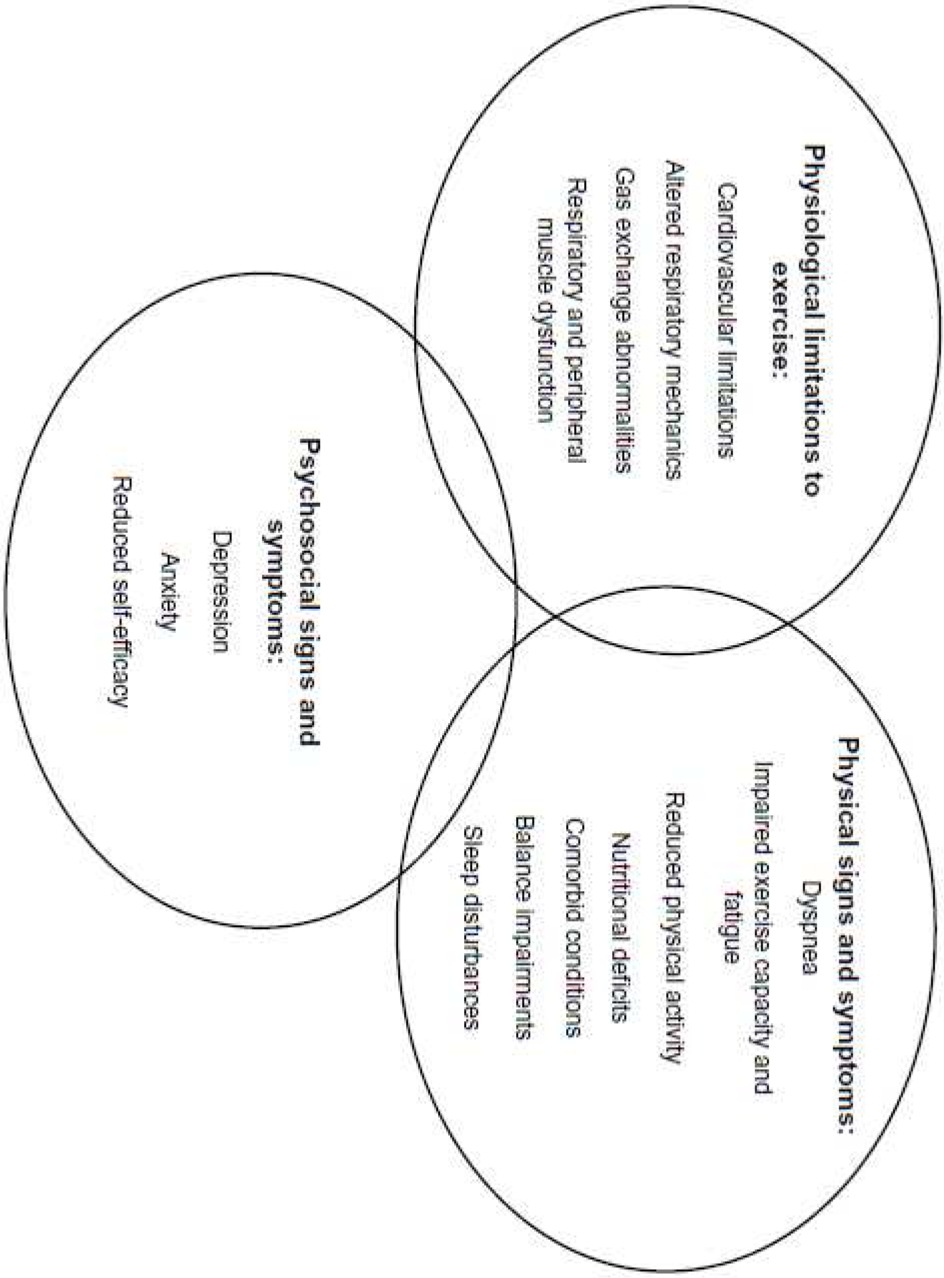
Fisiopatologia

Physiological impairments include respiratory and skeletal muscle dysfunction, together with **sleep disruption** and symptoms of **anxiety and depression** are often observed.

The heterogeneous nature of COPD is further illustrated by variable body composition abnormalities and **nutritional deficits** as well as other concurrent **medical conditions** including cardiovascular disease, diabetes, osteoporosis, and osteoarthritis.

International Journal of COPD 2014:9 1275–1288

# Fisiopatologia




International Journal of COPD 2014:9 1275–1288

Pulmonary Rehabilitation

## AMERICAN THORACIC SOCIETY DOCUMENTS

**An Official American Thoracic Society/European Respiratory Society Policy Statement: Enhancing Implementation, Use, and Delivery of Pulmonary Rehabilitation**

Pulmonary rehabilitation (PR) is a "comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors"

Am J Respir Crit Care Med Vol 192, Iss 11, pp 1373–1386, Dec 1, 2015

# Practical recommendations for exercise training in patients with COPD

Rainer Gloeckl*, Blagoi Marinov# and Fabio Pitta¶

**TABLE 1** Benefits and evidence levels of pulmonary rehabilitation outcomes in chronic obstructive pulmonary disease (COPD)

| Benefits | Evidence |
|---|---|
| Improves exercise capacity | A |
| Reduces the perceived intensity of breathlessness | A |
| Improves health-related quality of life | A |
| Reduces the number of hospitalisations and hospital days | A |
| Reduces anxiety and depression associated with COPD | A |
| Strength and endurance training of the upper limbs improves arm function | B |
| Benefits extend well beyond the immediate period of training | B |
| Improves survival | B |
| Respiratory muscle training can be beneficial, especially when combined with general exercise training | C |

Category A: randomised controlled trials, rich body of data; Category B: randomised controlled trials, limited body of data; Category C: nonrandomised trials or observational studies. Reproduced from [3] with permission from the publisher.

Eur Respir Rev 2013; 22: 128, 178–186

**TABELLA 3.5 Benefici della riabilitazione respiratoria nella BPCO**

- Migliora la capacità di esercizio fisico (**Evidenza A**)
- Riduce la percezione di intensità della dispnea (**Evidenza A**)
- Migliora la qualità di vita legata alla salute (**Evidenza A**)
- Riduce il numero di ricoveri ospedalieri e i giorni di ricovero (**Evidenza A**)
- Riduce l'ansia e la depressione associate alla BPCO (**Evidenza A**)
- L'allenamento di forza e resistenza degli arti superiori migliora la funzione delle braccia (**Evidenza B**)
- I benefici si estendono ben oltre l'immediato periodo di allenamento (**Evidenza B**)
- Migliora la sopravvivenza (**Evidenza B**)
- L'allenamento dei muscoli respiratori è di beneficio, specialmente se combinato con un allenamento fisico generico (**Evidenza C**)
- Migliora la ripresa dopo ricovero per una riacutizzazione (**Evidenza A**)[524]
- Aumenta l'effetto dei broncodilatatori a lunga durata d'azione (**Evidenza B**)

The NEW ENGLAND JOURNAL of MEDICINE

CLINICAL THERAPEUTICS

# Pulmonary Rehabilitation for Management of Chronic Obstructive Pulmonary Disease

Richard Casaburi, Ph.D., M.D., and Richard ZuWallack, M.D.

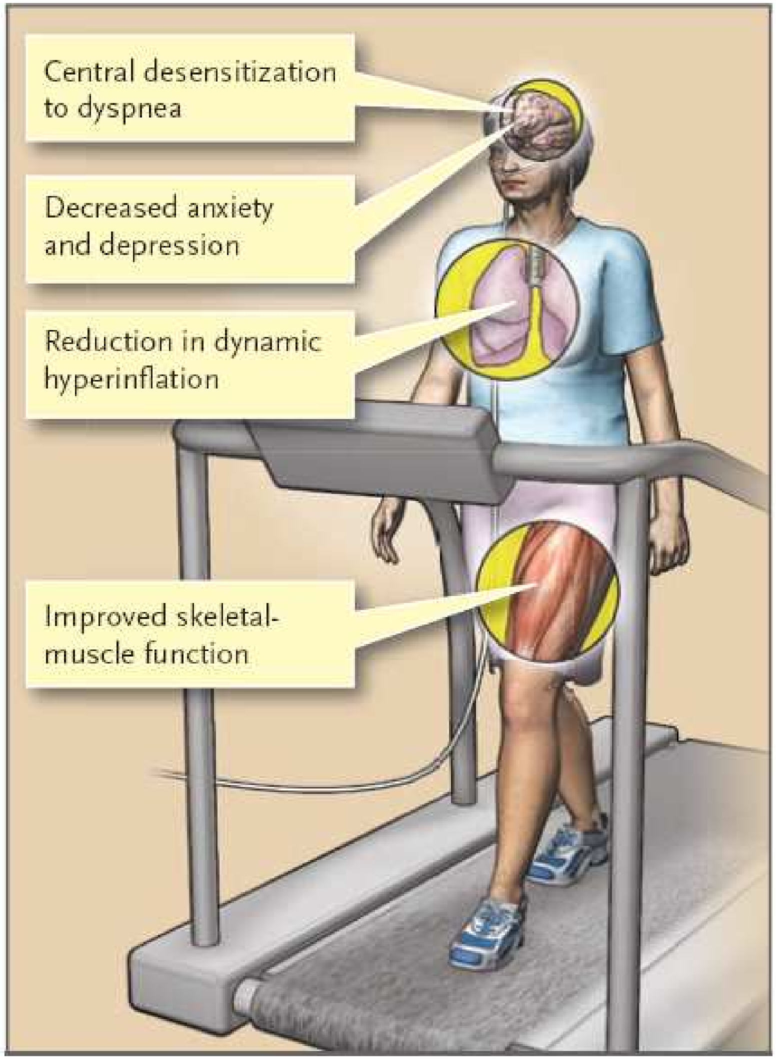



**Figure 1. Targets of Exercise Training as Part of a Pulmonary Rehabilitation Program for Patients with COPD.**

Exercise training does not improve lung function, but it does ease other manifestations of COPD, increasing exercise tolerance, reducing dyspnea, and improving quality of life. Improved skeletal-muscle function is related, in part, to a reversal of deconditioning. Exercise training improves aerobic function of the muscles of ambulation. Dyspnea is mitigated by the reduction in dynamic hyperinflation that occurs when exercise-induced increases in the rate and depth of breathing result in inadequate time for full expiration, given the high expiratory airflow resistance. End-expiratory lung volume rises, and exercise is terminated when end-inspiratory lung volume approaches levels at which the high elastic work of breathing causes severe dyspnea. Exercise training reduces the ventilatory requirement and respiratory rate during heavy exercise, prolonging the time allowed for expiration and reducing dynamic hyperinflation. Desensitization to dyspnea occurs centrally as a result of exercise training; the underlying mechanism is uncertain. Decreased anxiety and depression are thought to result from increased exercise capacity and consequent increases in activities of daily living, coupled with feelings of mastery.

Pulmonary rehabilitation does not directly improve lung mechanics or gas exchange. Rather, it optimizes the function of other body systems so that the effect of lung dysfunction is minimized

N Engl J Med 2009;360:1329-35.

Pulmonary Rehabilitation

High-intensity rehabilitative exercise programs improve muscle function by inducing changes in **muscle biochemistry**.

As a result, higher work rates can be tolerated without appreciable **lactic acidosis**.

For patients in whom ambulatory **muscle dysfunction** is a primary limitation, delayed fatigue directly enhances exercise tolerance.

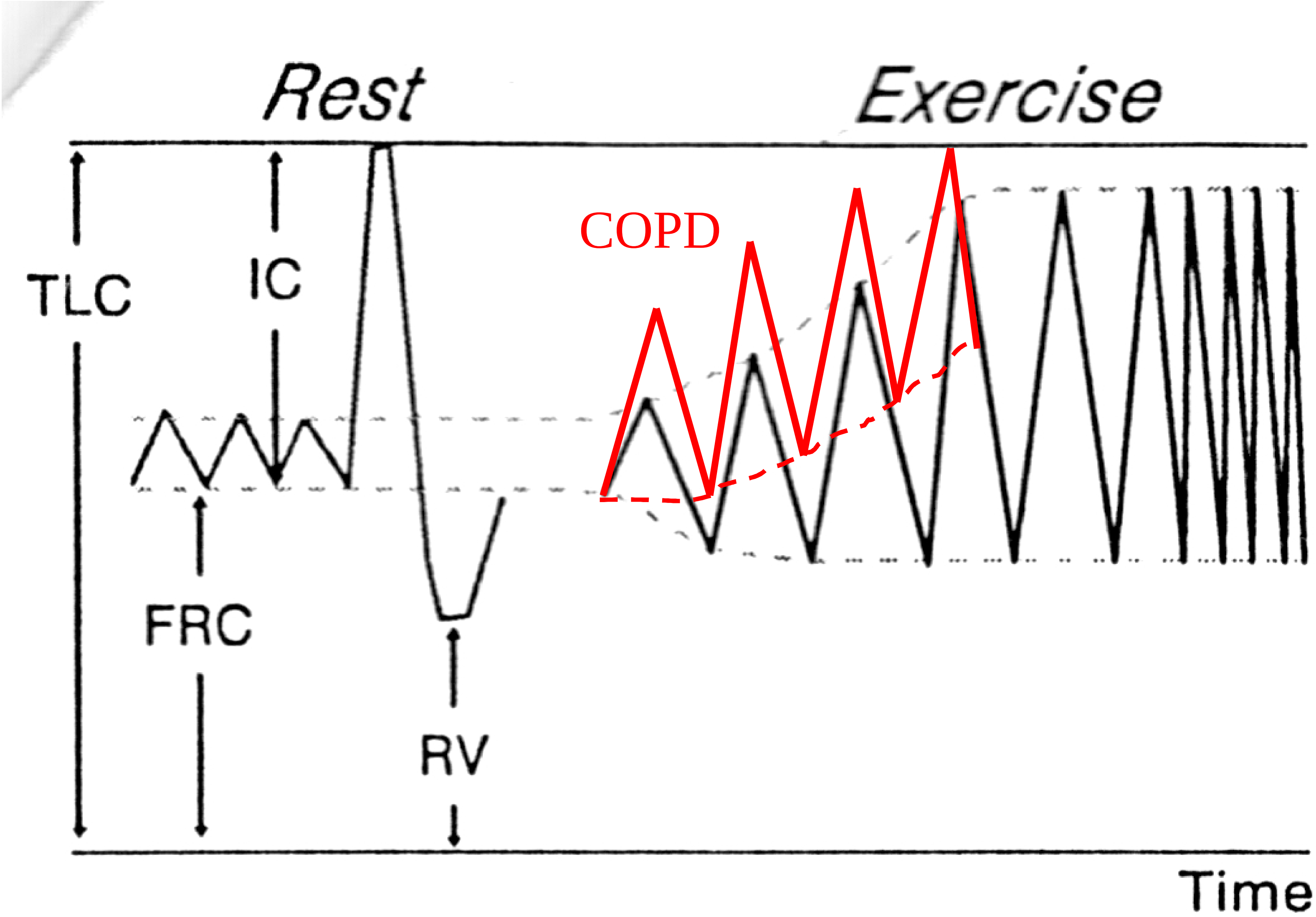
For patients in whom **ventilatory limitation** is primary, decreased lactic acidosis at a given level of exercise decreases ventilatory demand, probably by means of decreased carotid-body stimulation.

N Engl J Med 2009;360:1329-35.

Dyspnea is also mitigated by **reducing dynamic hyperinflation**, which results when exercise leads to increased ventilatory demand and inadequate time is allowed for expiration, given the limitations on expiratory airflow.

End-expiratory and, therefore, end-inspiratory lung volume is forced to increase progressively. When end-inspiratory **lung volume approaches the limiting volume** (total lung capacity), the elastic work of breathing and dyspnea increase markedly.

N Engl J Med 2009;360:1329-35.



Rest
Exercise
TLC
IC
COPD
FRC
RV
Time

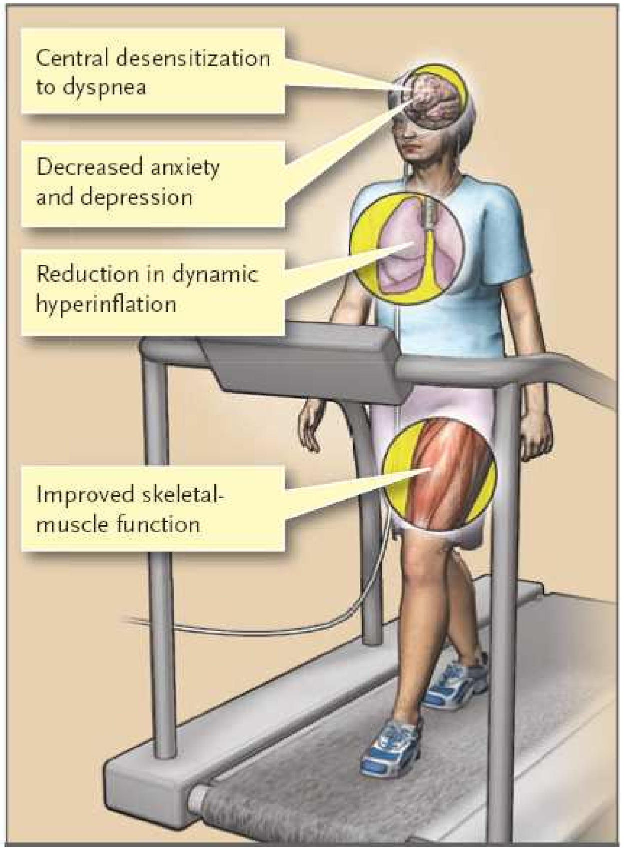
Exercise training **lowers ventilatory demand**, resulting in a slowing of respiration at a given level of exercise. With a longer expiratory time there is less dynamic hyperinflation and, therefore, less dyspnea.

N Engl J Med 2009;360:1329-35.

Pulmonary Rehabilitation

Pulmonary rehabilitation also works through other, less well-defined mechanisms.

- **Desensitization to dyspnea** (a decrease in the perception of dyspnea for a given task). Factors hypothesized to contribute to this desensitization include the antidepressant effect of exercise as well as the social interaction and distraction from dyspneic sensations that occur during exercise with a group of patients who have the same condition.

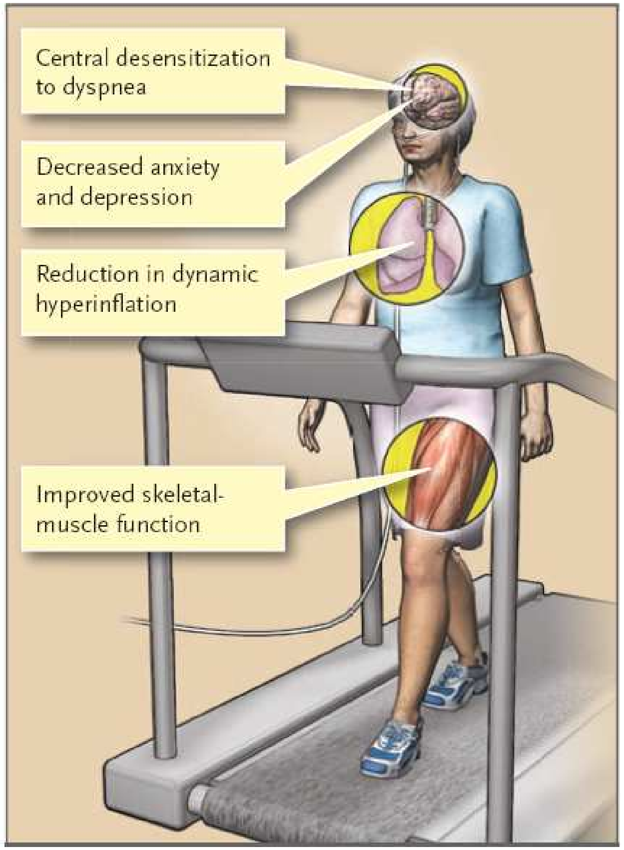



N Engl J Med 2009;360:1329-35.

Pulmonary Rehabilitation

Pulmonary rehabilitation also works through other, less well-defined mechanisms.

- **Education** in the development of **self-management strategies**: an approach that involves a partnership between the patient and health professionals to system. This approach promotes adaptive behaviors, such as abstinence from smoking, better adherence to pharmacologic and exercise therapy, and earlier recognition and treatment of COPD exacerbations




N Engl J Med 2009;360:1329-35.

# INDICAZIONI AL TRATTAMENTO

Chi riabilitare

Forced expiratory volume in 1 second (FEV1) is not the sole criterion for selecting patients for pulmonary rehabilitation, but patients who are typically referred for rehabilitation in the United States have stage 3 (severe) disease according to the four-stage Global Initiative for Chronic Obstructive Lung Disease (GOLD) classification of severity

**Table 1.** Spirometric Classification of COPD Severity on the Basis of Post-Bronchodilator $FEV_1$.*

| Stage and Severity | Definition |
|---|---|
| I — mild | $FEV_1/FVC < 0.70$, $FEV_1 \geq 80\%$ of predicted |
| II — moderate | $FEV_1/FVC < 0.70$, $50\% \leq FEV_1 < 80\%$ of predicted |
| III — severe | $FEV_1/FVC < 0.70$, $30\% \leq FEV_1 < 50\%$ of predicted |
| IV — very severe | $FEV_1/FVC < 0.70$, $FEV_1 < 30\%$ of predicted or $FEV_1 < 50\%$ of predicted plus chronic respiratory failure |

N Engl J Med 2009;360:1329-35.

Pulmonary Rehabilitation

AMERICAN THORACIC SOCIETY DOCUMENTS

**An Official American Thoracic Society/European Respiratory Society Policy Statement: Enhancing Implementation, Use, and Delivery of Pulmonary Rehabilitation**

Although PR benefits persons with many respiratory disorders, much of the published literature has, historically, **centered on COPD**.

Provision of PR services for persons with COPD should be **based on symptoms and functional status limitation** rather than solely on the severity of lung function impairment.

Am J Respir Crit Care Med Vol 192, Iss 11, pp 1373–1386, Dec 1, 2015

# AMERICAN THORACIC SOCIETY DOCUMENTS

## An Official American Thoracic Society/European Respiratory Society Policy Statement: Enhancing Implementation, Use, and Delivery of Pulmonary Rehabilitation

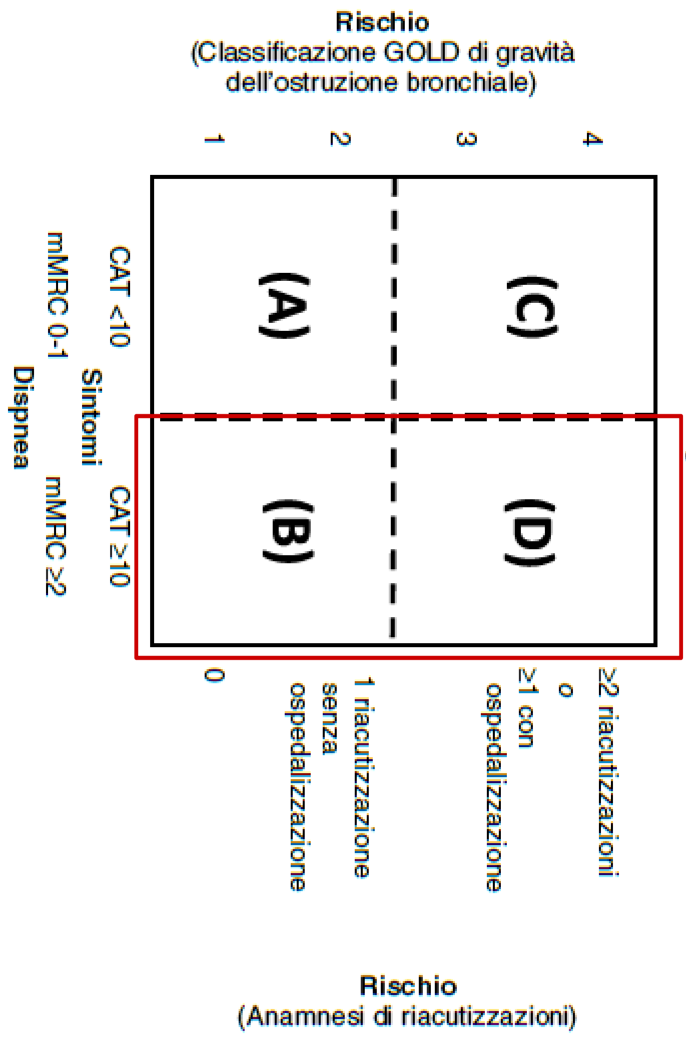
PR effectively addresses several issues also experienced by persons with **mild to moderate COPD**, including exertional dyspnea, dynamic hyperinflation, skeletal muscle dysfunction, low physical activity levels, depression, risk and impact of comorbidities such as cardiovascular disease, exacerbations of COPD, and impaired quality of life

Am J Respir Crit Care Med Vol 192, Iss 11, pp 1373–1386, Dec 1, 2015

# Chi riabilitare

**FIGURA 2.3 Combinazione di sintomi, classificazione spirometrica e rischio futuro di riacutizzazioni**

*Progetto strategico mondiale per la diagnosi, il trattamento e la prevenzione della BPCO: valutazione combinata di gravità della BPCO*

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# AMERICAN THORACIC SOCIETY DOCUMENTS

## An Official American Thoracic Society/European Respiratory Society Policy Statement: Enhancing Implementation, Use, and Delivery of Pulmonary Rehabilitation

However, in some jurisdictions, access to PR is limited by regulations specifying insurance coverage of PR only for stable patients with COPD who have moderate to severe airflow obstruction.
Such **policies are not in line with strong evidence** from randomized trials that show that both patients with unstable COPD who start rehabilitation during or after an exacerbations and patients with stable mild to moderate COPD benefit from rehabilitation

Am J Respir Crit Care Med Vol 192, Iss 11, pp 1373–1386, Dec 1, 2015

Chi riabilitare

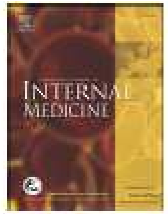
In general, pulmonary rehabilitation **is not recommended** for patients who are **unable to walk** (because of orthopedic or neurologic disorders) or those with **unstable cardiac disease** (unstable angina or recent myocardial infarction).

Other relative contraindications include cognitive or **psychiatric** problems that would prevent the patient from comprehending or cooperating with the treatment plan. Some programs exclude active **smokers**, although there are no convincing data that support this decision.

N Engl J Med 2009;360:1329-35.

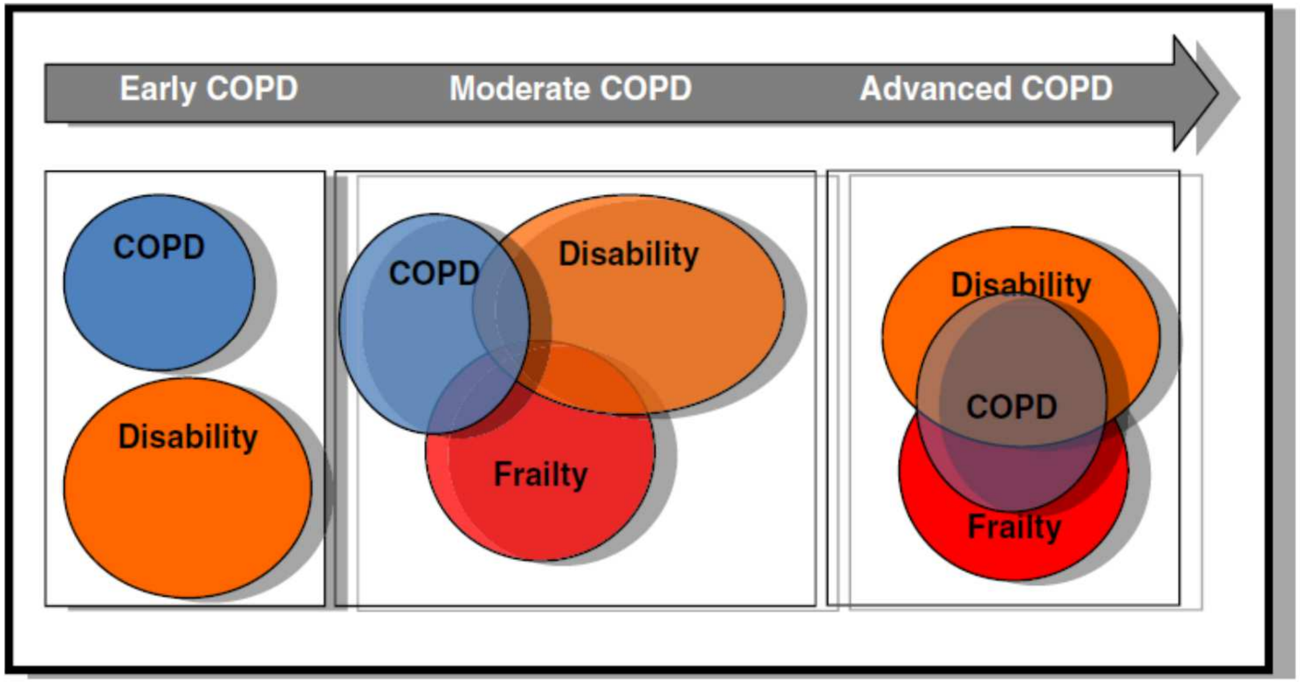
# Chi riabilitare

Contents lists available at ScienceDirect
European Journal of Internal Medicine
journal homepage: www.elsevier.com/locate/ejim



## Rehabilitation and supportive therapy in elderly patients with Chronic Obstructive Pulmonary Disease

Ernesto Crisafulli [a], Alessandro Morandi [b], Alessia Olivini [c], Mario Malerba [c], Enrico M. Clini [d,*]




European Journal of Internal Medicine 25 (2014) 329–335

Assessment

# Assessment

**Incremental cycle ergometry**

A progressively increasing work rate protocol enables rapid acquisition of diagnostic data.

Because the response of some of the major interesting variables, such as minute ventilation, V'O2 and carbon dioxide uptake, lags behind changes in work rate, it is important to employ a protocol in which work rate increases at a constant rate

Eur Respir Rev 2013; 22: 128, 178-186

Assessment

## 6-min walk test

The 6MWT is probably the most popular field walking test used for patients with respiratory disorders. It evaluates the **global and integrated responses of all systems** involved during exercise, including the pulmonary and cardiovascular system, neuromuscular units and muscle metabolism.

It is generally believed that the self-paced 6MWT assesses the **sub-maximal level of functional capacity**, although reaching high levels of cardiopulmonary stress.

The 6-min walking distance (6MWD) seems to **better reflect** the function **exercise level for daily physical activities** than maximal incremental tests

Eur Respir Rev 2013; 22: 128, 178–186

Assessment

The 6MWT requires a 30-m hallway but no exercise equipment.

The test measures the distance that a patient is able to walk quickly on a flat, hard surface in a period of 6 min back and forth around cones.

A rigorous standardisation of the test procedure, especially concerning the verbal communication before and during the test, is very important to minimise a potential bias by the tester

Eur Respir Rev 2013; 22: 128, 178–186

## Incremental shuttle walking tests

The incremental shuttle walking test (ISWT) is also a field walking test; however, it differs from the 6MWT as it uses an audio signal from a CD player to determine the walking pace of the patient back and forth on a 10-m course.

The walking speed increases every minute, and the test ends when the patient is not able to reach the turnaround point within the required time.

The distance walked is noted as a primary outcome parameter. The power output is similar to a symptom-limited, maximal, incremental treadmill test.

Eur Respir Rev 2013; 22: 128, 178–186

Assessment

**Incremental shuttle walking tests**

An advantage of the ISWT is that it shows a better correlation with peak V'O2 than the 6MWD as this test determines the maximum exercise capacity.

Disadvantages include less widespread use and more potential for cardiovascular risks, since it evokes maximal exertion from the patients.

Eur Respir Rev 2013; 22: 128, 178–186

## Sit-to-stand tests

Another simple test procedure to determine functional exercise capacity is a sit-to-stand test. The test involves either the number of sit-to-stand repetitions from a standard chair within 30 s, respectively 60 s, or quantifies the time that a patient needs to perform, for example, five repetitions in a row.

These tests may also **determine functional status as easily** as the 6MWT in regard to neurophysiologic effectiveness.

Eur Respir Rev 2013; 22: 128, 178–186

Assessment

## Peripheral muscle strength testing

As COPD is a disease with extrapulmonary, systemic manifestations such as muscle dysfunction, it is also important to assess peripheral muscle function.

Muscle strength is usually expressed as the maximal voluntary isometric force of a muscle. As a reflection of lower limb strength, the quadriceps femoris muscle is, mostly, tested. Important requirements for a valid measurement are a proper fixation of the patient so that they cannot make any evasion movement

Eur Respir Rev 2013; 22: 128, 178–186

Assessment

## Peripheral muscle strength testing

Devices such as an isokinetic dynamometer, a special chair using a strain gauge fixed at the ankle, or hand-held dynamometers can be used to determine muscle strength.

Handgrip force, measured by a handgrip dynamometer, can be considered as an indicator for upper extremity strength.

Eur Respir Rev 2013; 22: 128, 178–186

Setting

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CLINICAL THERAPEUTICS

Pulmonary Rehabilitation for Management of Chronic Obstructive Pulmonary Disease

Richard Casaburi, Ph.D., M.D., and Richard ZuWallack, M.D.

N Engl J Med 2009;360:1329-35.

- Hospital-based outpatient program
- Homebased
- Community-based
- Inpatient settings

Many rehabilitation programs feature three directly supervised sessions per week, each lasting 3 to 4 hours. The duration of most programs ranges from 6 to 12 weeks, although some studies suggest that longer programs may provide additional and more durable benefits

Setting

-L’allenamento fisico varia con frequenza da quotidiana a settimanale, con durata tra i 10 e i 45 minuti per seduta e con intensità dal 50% del picco di consumo di ossigeno (VO2 max) al massimo tollerato.

La lunghezza ottimale di un programma di esercizio non è stata esaminata in studi clinici randomizzati controllati, ma la maggior parte degli studi con meno di 28 sedute di esercizio mostrano  risultati inferiori rispetto a quelli con periodi di trattamento più lunghi.

In pratica, la durata dipende dalle risorse disponibili e generalmente varia dalle 4 alle 10 settimane, con conseguenti effetti maggiori per i programmi più lunghi rispetto ai programmi più corti

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Endurance Training

## Endurance training

Endurance training is probably the **most common** exercise modality in patients with COPD.

The main objective of endurance training is to improve **aerobic exercise** capacity as aerobic activities are part of many everyday tasks in these patients.

It has been shown that endurance training also improves **peripheral muscle function** in patients with COPD

Eur Respir Rev 2013; 22: 128, 178–186

## Endurance Training

High intensity training, defined as greater than 60% of maximal work rate for a duration of 20 to 60 minutes is associated with greater benefits compared to lower intensity.

The selection of this intensity is based on the rationale for addressing skeletal muscle weakness, with a **sufficient anabolic stimulus required to target the skeletal muscle's oxidative capacity**.

In patients with COPD, a target level for symptoms of dyspnea of 4 to 6 (moderate to very severe) or rating of perceived exertion of 12 to 14 (somewhat hard) is considered to reflect an appropriate training intensity.

Eur Respir Rev 2013; 22: 128, 178–186

Endurance Training

# Time to adapt exercise training regimens in pulmonary rehabilitation – a review of the literature

International Journal of COPD

The most common modes of endurance training tested in COPD are **walking (ground-based or treadmill walking) and stationary cycling**.

This type of exercise is associated with improvement in maximal exercise capacity following endurance training, reflected by increased VO2 peak and peak work rate and greater endurance capacity for treadmill-based tests and cycle ergometry.

The **improvement in aerobic metabolism** of skeletal muscles **reduces the ventilation** requirements for a given workload, which is reflected by reduced dyspnea and greater tolerance of daily activities

International Journal of COPD
10 November 2014

## Continuous versus interval training

However, most patients with severe COPD are not able to sustain high-intensity exercise due to serious symptoms, such as dyspnoea and fatigue .

Therefore, alternative exercise protocols, such as interval training, have gained increasing interest especially in patients with advanced COPD.

| TABLE 3 | Practical indications for considering the use of an interval training approach |
|---|---|
| **Interval training may be more appropriate when the patient presents with:** | |
| A severe airflow obstruction ($FEV_1$ <40% pred) | |
| A low exercise capacity (peak work rate <60% pred) | |
| A total time at a constant work rate test of <10 min | |
| A marked oxygen desaturation during exercise ($S_{pO_2}$ <85%) | |
| An intolerable dyspnoea during continuous endurance training | |

$FEV_1$: forced expiratory volume in 1 s; % pred: % predicted; $S_{pO_2}$: arterial oxygen saturation measured by pulse oximetry.

Eur Respir Rev 2013; 22: 128, 178–186

Endurance Training

## Continuous versus interval training

Although interval training consists of a sequence of on-and-off high-intensity muscular loads, its tolerability in the context of perceived respiratory and peripheral muscle discomfort has been shown to be better than that of constant load exercise.

In general, many patients are frustrated by the burden of physical limitation in daily life. To avoid frustration during exercise training it may be important to offer exercise protocols that are feasible to each specific patient.

Eur Respir Rev 2013; 22: 128, 178–186

# Endurance Training

**TABLE 2** Practical recommendations for the implementation of continuous and interval endurance training programmes

| | Continuous endurance training | Interval endurance training |
|---|---|---|
| **Frequency** | 3–4 days·week$^{-1}$ | 3–4 days·week$^{-1}$ |
| **Mode** | Continuous | Interval modes:<br>30 s of exercise, 30 s of rest or<br>20 s of exercise, 40 s of rest |
| **Intensity** | Initially 60–70% of PWR<br>Increase work load by 5–10% as tolerated<br>Progressively try to reach ~80–90% of baseline PWR | Initially 80–100% of PWR for the first three to four sessions<br>Increase work load by 5–10% as tolerated<br>Progressively try to reach ~150% of baseline PWR |
| **Duration** | Initially 10–15 min for the first three to four sessions<br>Progressively increase exercise duration to 30–40 min | Initially 15–20 min for the first three to four sessions<br>Progressively increase exercise duration to 45–60 min (including resting time) |
| **Perceived exertion** | Try to aim for a perceived exertion on the 10-point Borg scale of 4 to 6 | Try to aim for a perceived exertion on the 10-point Borg scale of 4 to 6 |
| **Breathing technique** | Suggest pursed-lip breathing or the use of PEP devices to prevent dynamic hyperinflation and to reduce breathing frequency | Suggest pursed-lip breathing or the use of PEP devices to prevent dynamic hyperinflation and to reduce breathing frequency |

PWR: peak work rate; PEP: positive expiratory pressure. Adapted from [30].

Eur Respir Rev 2013; 22: 128, 178–186

Resistance Training

Impact of Resistance Training in Subjects With COPD: A Systematic Review and Meta-Analysis

Wen-hua Liao, Jin-wu Chen MM, Xin Chen MD, Lin Lin, Hai-yan Yan MM, Yu-qi Zhou MD, and Rui Chen MD

## Resistance strength training

Improved leg strength aids in some activities of daily living and may lessen the risk of falls (although this benefit has yet to be demonstrated in clinical trials).

Resistance training that involves the upper arms is also useful, both because it facilitates the ability to carry out the activities of daily living and because some of the upper-arm muscles also serve as auxiliary muscles

RESPIRATORY CARE • AUGUST 2015 VOL 60 NO 8

# Resistance Training

## Time to adapt exercise training regimens in pulmonary rehabilitation – a review of the literature

International Journal of COPD

**Table 1** Lower and upper limb muscle groups targeted for resistance training and options for exercise

| Muscles targeted | Type of exercise |
|---|---|
| **Lower limb training** | |
| Quadriceps | Free weights |
| Hamstrings | Weight machine |
| Gluteus maximum/medius | – Leg press, quadriceps extension |
| Gastrocnemius | Elastic bands |
| Soleus | Pulleys |
| | Functional tasks |
| | – Sit–stand, step-ups or stair climbing, squats, straight leg raise |
| **Upper limb training** | **Supported** |
| Pectoralis major/minor | – Arm ergometry |
| Latissimus dorsi | – Weight machine |
| Trapezius | – Chest press, latissimus pull-down |
| Triceps | **Unsupported** |
| Biceps | – Free weights |
| | – Elastic bands |
| | – Dowel lifts |
| | – Wall push offs |
| | – Functional tasks |
| | – Ball throwing against a wall |
| | – Pulleys |

International Journal of COPD
10 November 2014

# Resistance Training

**TABLE 4** Practical recommendations for the implementation of strength training

| | |
|---|---|
| **Frequency** | 2–3 days·week$^{-1}$ |
| **Objective** | Targeting for local muscular exhaustion within a given number of repetitions for major muscle groups of upper and lower extremities |
| **Mode** | Two to four sets of six to 12 repetitions |
| **Intensity** | 50–85% of one repetitive maximum as a reference point |
| | Increase work load by 2–10% if one to two repetitions over the desired number are possible on two consecutive training sessions |
| **Speed** | Moderate (1–2 s concentric and 1–2 s eccentric) |

Data from [53].

Eur Respir Rev 2013; 22: 128, 178–186

# Resistance Training

## A combination of resistance and endurance training increases leg muscle strength in COPD: An evidence-based recommendation based on systematic review with meta-analyses

Ulrik Winning Iepsen[1], Karsten Juhl Jørgensen[2], Thomas Ringbæk[3], Henrik Hansen[4], Conni Skrubbeltrang[5] and Peter Lange[1,3,6]

| Study or Subgroup | Experimental Mean | Experimental SD | Experimental Total | Control Mean | Control SD | Control Total | Weight | Std. Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Alexander 2008 | 108 | 36 | 10 | 99 | 40 | 10 | 11.2% | 0.23 [−0.65, 1.11] |
| Vonbank 2012 | 136.2 | 139.6033 | 12 | 94.9 | 90.4131 | 12 | 13.3% | 0.34 [−0.47, 1.15] |
| Mador 2004 | 55 | 19.8997 | 11 | 45 | 11.8983 | 13 | 12.8% | 0.60 [−0.22, 1.43] |
| Bernard 1999 | 67 | 21 | 21 | 55 | 15 | 15 | 18.7% | 0.63 [−0.05, 1.31] |
| Philips 2006 | 102 | 41.1096 | 10 | 76 | 27 | 9 | 9.9% | 0.71 [−0.23, 1.64] |
| Ortega 2002 | 55 | 10 | 14 | 47 | 9 | 16 | 15.4% | 0.82 [0.07, 1.57] |
| Dourado 2009 | 116 | 32 | 11 | 85 | 20 | 13 | 11.3% | 1.14 [0.27, 2.02] |
| Panton 2003 | 841 | 342 | 9 | 460 | 176 | 8 | 7.5% | 1.30 [0.23, 2.38] |
| **Total (95% CI)** | | | **98** | | | **96** | **100.0%** | **0.69 [0.39, 0.98]** |

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 4.27$, $df = 7$ ($P = 0.75$); $I^2 = 0\%$
Test for overall effect: $Z = 4.57$ ($P < 0.00001$)

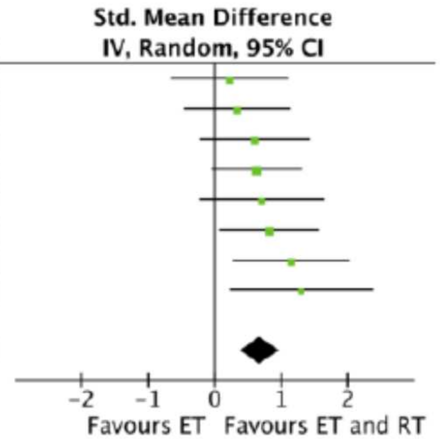



**Figure 4.** The effect of RT and ET compared to ET alone. Outcome: leg muscle strength. RT: resistance training; ET: endurance training.

# Inspiratory/Expiratory Training

## Expiratory and Expiratory Plus Inspiratory Muscle Training Improves Respiratory Muscle Strength in Subjects With COPD: Systematic Review

Leonardo F Neves PT, Manoela H Reis PT, Rodrigo DM Plentz PT ScD,
Darlan L Matte PT ScD, Christian C Coronel PT MSc, and Graciele Sbruzzi PT ScD

| | EMT | | | Control | | | | Mean Difference |
|---|---|---|---|---|---|---|---|---|
| Study or Subgroup | Mean | SD | Total | Mean | SD | Total | Weight | IV, Random, 95% CI |
| 2.1.1 $P_{E_{max}}$ | | | | | | | | |
| Battaglia et al, 2009 | 97 | 8 | 16 | 64 | 8 | 16 | 83.0% | 33.00 [27.46, 38.54] |
| Weiner et al, 2003b | 105 | 13.8 | 8 | 78 | 11 | 8 | 17.0% | 27.00 [14.77, 39.23] |
| Subtotal (95% CI) | | | 24 | | | 24 | 100.0% | 7.68 [0.90, 14.45] |
| Heterogeneity: Tau² = 0.00; Chi² = 0.98, df = 1 (P = .38); I² = 0% | | | | | | | | |
| Test for overall effect: Z = 12.41 (P < .00001) | | | | | | | | |
| 2.1.2 $P_{I_{max}}$ | | | | | | | | |
| Battaglia et al, 2009 | 81 | 8 | 16 | 64 | 8 | 16 | 50.4% | 25.00 [13.91, 36.09] |
| Weiner et al, 2003b | 90 | 13.8 | 8 | 78 | 11 | 8 | 49.6% | 31.00 [19.82, 42.18] |
| Subtotal (95% CI) | | | 24 | | | 24 | 100.0% | 10.00 [-1.91, 21.91] |
| Heterogeneity: Tau² = 0.00; Chi² = 0.56, df = 1 (P = .46); I² = 0% | | | | | | | | 27.98 [20.10, 35.85] |
| Test for overall effect: Z = 6.97 (P < .00001) | | | | | | | | |

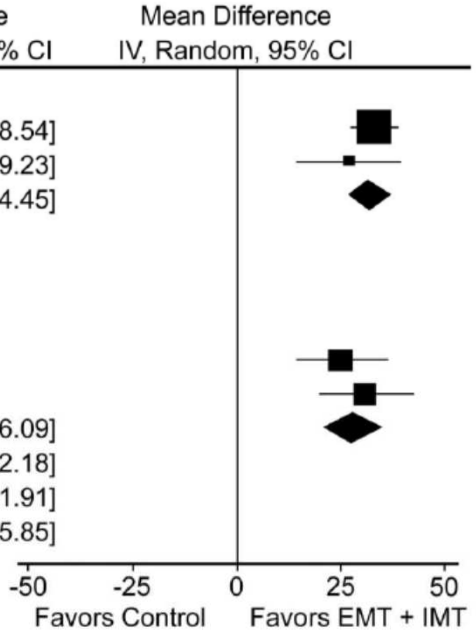



Fig. 5. Comparison between expiratory muscle training (EMT) combined with inspiratory muscle training (IMT) and control groups for maximum expiratory pressure ($P_{E_{max}}$) and maximum inspiratory pressure ($P_{I_{max}}$).

# Training

| TABLE 5 | Practical recommendations for the implementation of inspiratory muscle training (IMT) |
|---|---|
| **Frequency** | 5–7 days·week$^{-1}$ |
| **Objective** | To increase inspiratory muscle strength in patients with inspiratory muscle weakness ($P_{Imax}$ <60 $cmH_2O$) |
| **Mode** | Most commonly threshold loading |
| **Intensity** | Initially ≥30% of $P_{Imax}$ |
| | Increase load as tolerated |
| **Duration** | For example, using an interval approach with 7 × 2 min of IMT and 1 min of rest between each interval |

$P_{Imax}$: maximal inspiratory pressure. Data from [60, 62].

Pep/Rmt™

Eur Respir Rev 2013; 22: 128, 178–186

# Inspiratory/Expiratory Training

# Expiratory and Expiratory Plus Inspiratory Muscle Training Improves Respiratory Muscle Strength in Subjects With COPD: Systematic Review

Leonardo F Neves PT, Manoela H Reis PT, Rodrigo DM Plentz PT ScD, Darlan L Matte PT ScD, Christian C Coronel PT MSc, and Graciele Sbruzzi PT ScD

| Study or Subgroup | EMT Mean | EMT SD | EMT Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|---|---|---|---|
| 2.1.1 $P_{E_{max}}$ | | | | | | | | |
| Battaglia et al, 2009 | 97 | 8 | 16 | 64 | 8 | 16 | 83.0% | 33.00 [27.46, 38.54] |
| Weiner et al, 2003b | 105 | 13.8 | 8 | 78 | 11 | 8 | 17.0% | 27.00 [14.77, 39.23] |
| Subtotal (95% CI) | | | 24 | | | 24 | 100.0% | 7.68 [0.90, 14.45] |
| Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.98$, df = 1 (P = .38); $I^2 = 0\%$ | | | | | | | | |
| Test for overall effect: Z = 12.41 (P < .00001) | | | | | | | | |
| 2.1.2 $P_{I_{max}}$ | | | | | | | | |
| Battaglia et al, 2009 | 81 | 8 | 16 | 64 | 8 | 16 | 50.4% | 25.00 [13.91, 36.09] |
| Weiner et al, 2003b | 90 | 13.8 | 8 | 78 | 11 | 8 | 49.6% | 31.00 [19.82, 42.18] |
| Subtotal (95% CI) | | | 24 | | | 24 | 100.0% | 10.00 [-1.91, 21.91] |
| Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.56$, df = 1 (P = .46); $I^2 = 0\%$ | | | | | | | | 27.98 [20.10, 35.85] |
| Test for overall effect: Z = 6.97 (P < .00001) | | | | | | | | |

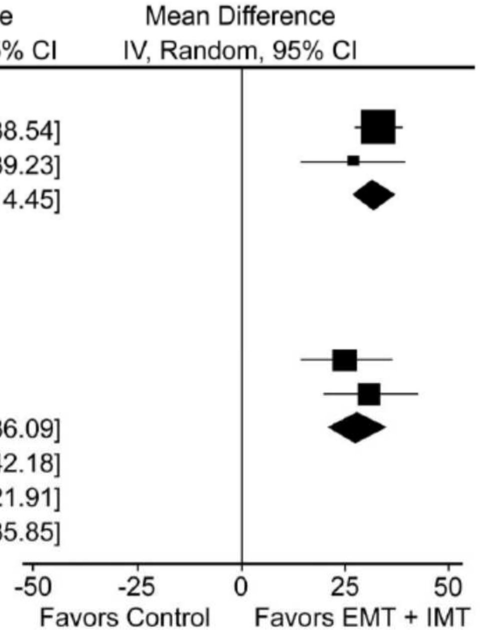



Fig. 5. Comparison between expiratory muscle training (EMT) combined with inspiratory muscle training (IMT) and control groups for maximum expiratory pressure ($P_{E_{max}}$) and maximum inspiratory pressure ($P_{I_{max}}$).

# Psychological interventions

Official Journal of the Asian Pacific Society of Respirology
Respirology
APSR

## Exercise training combined with psychological interventions for people with chronic obstructive pulmonary disease

LOUISE WILES,[1] PAUL CAFARELLA[2] AND MARIE T. WILLIAMS[3]

**Table 1** Summary of participants' characteristics and intervention and control/comparator components

| | | Wijkstra *et al.*[29] | Wijkstra *et al.*[30] | Guell *et al.*[31] | Kayahan *et al.*[32] | Emery *et al.*[33] | Ries *et al.*[34] | de Godoy *et al.*[6] | Lindsay *et al.*[35] | de Godoy and de Godoy[5] | Norweg *et al.*[36] | de Blok *et al.*[37] | Berry *et al.*[38] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample size | 43 | 43 | 40 | 45 | 79 | 119 | 49 | 50 | 30 | 43 | 21 | 176 |
| | Mean age | 63 | 63 | 67 | 66 | 67 | 63 | >50 | 70 | 61 | 77 | 64 | 66 |
| | COPD diagnosis | S | S | S | S | S | S/P | S/P | S | S/P | S/P | S | S |
| | GOLD stage | 3 | 3 | 3 | 2 | 3 | 3 | 4 | 1 | 3 | 2 | 2/3 | 2 |
| Exercise training + psychological intervention | Exercise training | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Inspiratory muscle training | ■ | ■ | | | | | | | | | | |
| | Breathing retraining | | | ■ | | | | | | | | | |
| | Education | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ | | ■ | ■ |
| | Tiotropium | | | | | | | | ■ | | | | |
| | Dietary intervention | | | | | | | | | | | ■ | |
| | Relaxation training | ■ | ■ | ■ | ■ | | | | | | | | |
| | Stress management | | | | | ■ | | | | | | | |
| | Cognitive behavioral therapy | | | | | ■ | | | | ■ | | | |
| | Psychotherapy | | | | | | | ■ | | | | | |
| | Psychosocial support | | | | | | ■ | | ■ | | | | |
| | Activity training/counselling | | | | | | | | | | ■ | ■ | ■ |
| | Dyspnoea strategies | | | | | | | | | | ■ | | |
| | Motivational interviewing | | | | | | | | | | | ■ | |
| Control/comparator | Usual care | ■ | ■ | ■ | ■ | | | | | | | | |
| | Waiting list | | | | | ■ | | | | | | | |
| | Education | | | | | | ■ | | | ■ | ■ | ■ | ■ |
| | Exercise training | | | | | | | ■ | | ■ | ■ | ■ | ■ |
| | Psychotherapy | | | | | | | ■ | | | | | |
| | Tiotropium | | | | | | | | ■ | | | | |

Key

| COPD diagnosis: | | GOLD stages: | | | |
|---|---|---|---|---|---|
| S | Spirometry | GOLD stage 1 | Mild | GOLD Stage 3 | Severe |
| P | Physician | GOLD stage 2 | Moderate | GOLD stage 4 | Very severe |

*Respirology* (2015) **20**, 46–55

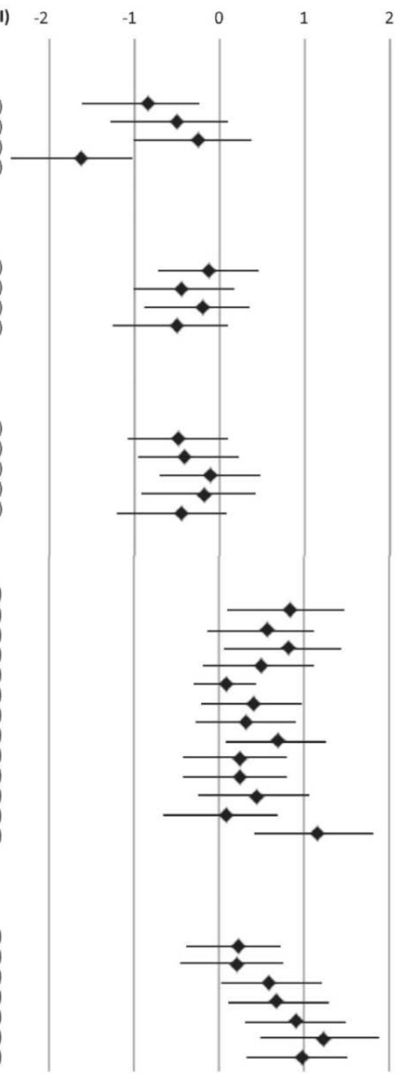
# Psychological interventions

Official Journal of the Asian Pacific Society of Respirology
Respirology

## Exercise training combined with psychological interventions for people with chronic obstructive pulmonary disease

LOUISE WILES,[1] PAUL CAFARELLA[2] AND MARIE T. WILLIAMS[3]

| | Outcome | SMD (95% CI) |
|---|---|---|
| **(a)** | | |
| ***Dyspnoea*** | | |
| Wijkstra *et al.*[29] | CRQ-D | -0.85 (-1.5, -0.20) |
| Wijkstra *et al.*[30] | Borg | -0.49 (-1.13, 0.14) |
| Guell *et al.*[31] | CRQ-D | -0.25 (-0.92, 0.42) |
| Kayahan *et al.*[32] | VVAS | -1.63 (-2.31, -0.95) |
| ***Anxiety*** | | |
| Emery *et al.* 1998[33](A) | SCL-90-R-A | -0.13 (-0.69, 0.42) |
| | STAI | -0.44 (-1.00, 0.12) |
| Guell *et al.*[31] | SCL-90-R A | -0.20 (-0.86, 0.47) |
| Kayahan *et al.*[32] | HAM-A | -0.50 (-1.1, 0.10) |
| ***Depression*** | | |
| Emery *et al.* 1998[33](A) | SCL-90-R-D | -0.49 (-1.05, 0.07) |
| | CES-D | -0.41 (-0.97, 0.15) |
| | ABS | -0.11 (-0.66, 0.45) |
| Guell *et al.*[31] | SCL-90-R D | -0.18 (-0.85, 0.48) |
| Kayahan *et al.*[32] | HAM-D | -0.46 (-1.05, 0.14) |
| **(b)** | | |
| ***Quality of life*** | | |
| Wijkstra *et al.*[29] | CRQ-D | 0.85 (0.20, 1.50)) |
| | CRQ-F | 0.57 (-0.07, 1.20) |
| | CRQ-E | 0.83 (0.18, 1.48) |
| | CRQ-M | 0.50 (-0.13, 1.14) |
| Emery *et al.* 1998[33](A) | MHLC-I | 0.09 (-0.34, 0.38) |
| | MHLC-PO | 0.40 (-0.15, 0.97) |
| | MHLC-C | 0.32 (-0.23, 0.88) |
| | SIP | 0.69 (0.12, 1.26) |
| Guell *et al.*[31] | CRQ-D | 0.25 (-0.42, 0.92) |
| | CRQ-D | 0.25 (-0.42, 0.92) |
| | CRQ-D | 0.45 (-0.22, 1.13) |
| | CRQ-D | 0.09 (-0.57, 0.75) |
| Kayahan *et al.*[32] | SGRQ | 1.16 (0.52, 1.80) |
| ***Functional exercise capacity*** | | |
| Wijkstra *et al.*[29] | W max | 0.23 (-0.30, 0.86) |
| Wijkstra *et al.*[30] | 6MWT | 0.22 (-0.41, 0.85) |
| Emery *et al.* 1998[33](A) | work | 0.59 (0.02, 1.15) |
| | max HR | 0.67 (0.10, 1.24) |
| | VO2 max | 0.91 (0.33, 1.49) |
| Guell *et al.*[31] | 6MWT | 1.23 (0.51, 1.95) |
| Kayahan *et al.*[32] | 6MWT | 0.99 (0.36, 1.61) |




*Respirology* (2015) **20**, 46–55

# Auditory Stimuli

## Distractive Auditory Stimuli in the Form of Music in Individuals With COPD

### A Systematic Review

*Annemarie L. Lee, PhD; Laura Desveaux, MScPT; Roger S. Goldstein, MD, FCCP; and Dina Brooks, PhD*

| Study or Subgroup | Mean Difference | SE | Control Total | DAS Total | Weight | Mean Difference IV, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| Bauldoff 2002 | 154.74 | 3.93 | 12 | 12 | 33.3% | 154.74 [147.04, 162.44] | 2002 |
| Liu 2008 | 58.46 | 3.43 | 24 | 24 | 33.3% | 58.46 [51.74, 65.18] | 2008 |
| Ho 2012 | 82 | 2.84 | 21 | 20 | 33.4% | 82.00 [76.43, 87.57] | 2012 |
| **Total (95% CI)** | | | **57** | **56** | **100.0%** | **98.36 [46.95, 149.76]** | |

Heterogeneity: $Tau^2 = 2052.03$; $Chi^2 = 362.87$, $df = 2$ ($P < 0.00001$); $I^2 = 99\%$
Test for overall effect: $Z = 3.75$ ($P = 0.0002$)

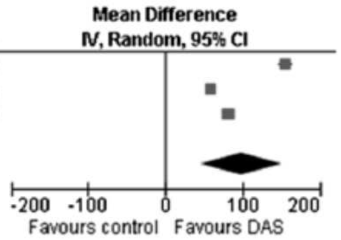



Figure 2 – *The effect of DAS vs control on exercise capacity at 2 mo follow-up. ■ = point estimate; ◆ = pooled effect estimate. DAS = distractive auditory stimulus; df = degrees of freedom; IV = independent variable.*

# Self-management

## Self-Management Following an Acute Exacerbation of COPD

### A Systematic Review

CHEST

*Samantha L. Harrison, PhD; Tania Janaudis-Ferreira, PhD; Dina Brooks, PhD; Laura Desveaux, MSc; and Roger S. Goldstein, MD, FCCP*

| Study or Subgroup | Intervention Events | Intervention Total | Control Events | Control Total | Weight | Odds Ratio M-H, Random, 95% CI |
|---|---|---|---|---|---|---|
| Bucknall et al. | 88 | 232 | 92 | 232 | 44.2% | 0.93 [0.64, 1.35] |
| Casas et al | 29 | 65 | 60 | 90 | 33.1% | 0.40 [0.21, 0.78] |
| Wood-Baker et al. | 22 | 33 | 22 | 36 | 22.6% | 1.27 [0.47, 3.41] |
| **Total (95% CI)** | | **330** | | **358** | **100.0%** | **0.76 [0.41, 1.41]** |
| Total events | 139 | | 174 | | | |

Heterogeneity: $Tau^2 = 0.19$; $Chi^2 = 5.67$, df = 2 (P = 0.06); $I^2 = 65\%$

Test for overall effect: Z = 0.88 (P = 0.38)

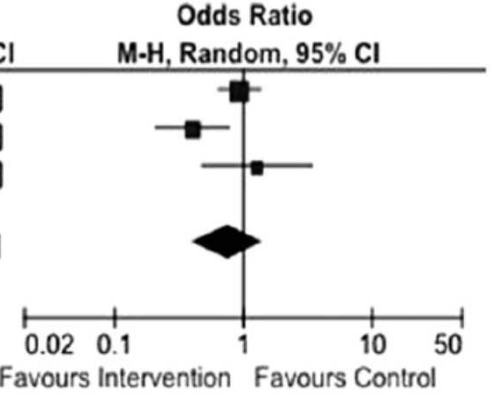



Figure 2 – *Results for the meta-analysis on hospital admissions. df = degrees of freedom; M-H = Mantel-Haenszel.*

# Physical activity

Eur Respir J 2012; 39: 272–278
DOI: 10.1183/09031936.00026011


## Trajectories of endurance activity following pulmonary rehabilitation in COPD patients

J.E. Soicher*,#, N.E. Mayo#,¶,+, L. Gauvin§, J.A. Hanley¶,+, S. Bernard$^f$, F. Maltais$^f$ and J. Bourbeau*,+

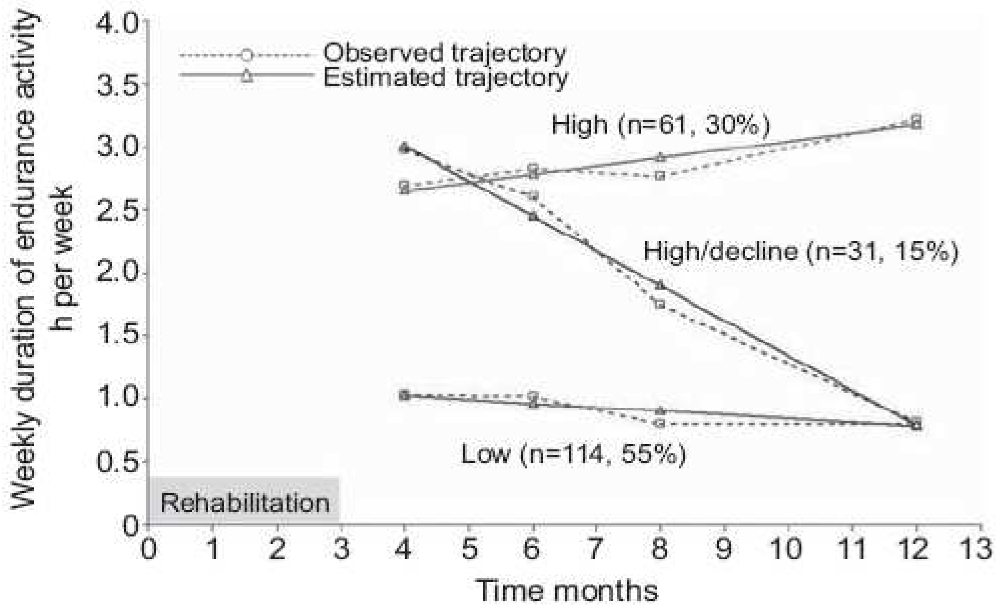



**FIGURE 1.** Three-class model showing the mean observed and estimated trajectories. The weekly duration of endurance activity plotted against time for high, high/decline and low trajectory groups. The grey box indicates the 3-month pulmonary rehabilitation programme.

# Physical activity

CONCISE CLINICAL REVIEW

## Pulmonary Rehabilitation and Physical Activity in Patients with Chronic Obstructive Pulmonary Disease

Martijn A. Spruit[1,2], Fabio Pitta[3], Edward McAuley[4], Richard L. ZuWallack[5], and Linda Nici[6]

Physical activity can be defined as "any bodily movement produced by skeletal muscles that results in energy expenditure"

Therefore, physical activity in daily life can be considered as "the totality of voluntary movement produced by skeletal muscles during every day functioning" and is assessed by the quantification of this totality of movements during daily life.

In distinction, exercise is "a subset of physical activity that is planned, structured, repetitive and purposeful"

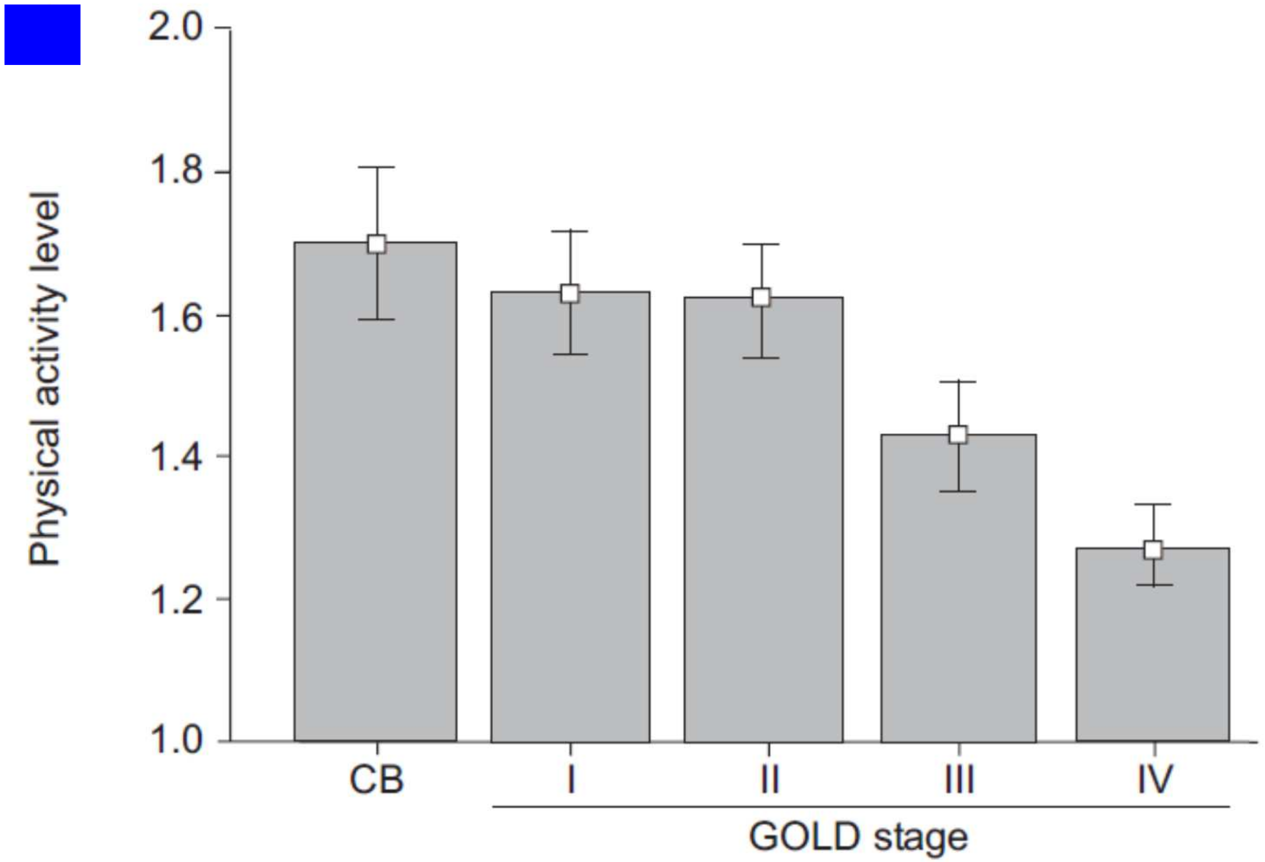
American Journal of Respiratory and Critical Care Medicine Volume 192 Number 8 | October 15 2015

# Physical activity

**TABELLA 3.5 Benefici della riabilitazione respiratoria nella BPCO**

- Migliora la capacità di esercizio fisico (**Evidenza A**)
- Riduce la percezione di intensità della dispnea (**Evidenza A**)
- Migliora la qualità di vita legata alla salute (**Evidenza A**)
- Riduce il numero di ricoveri ospedalieri e i giorni di ricovero (**Evidenza A**)
- Riduce l'ansia e la depressione associate alla BPCO (**Evidenza A**)
- L'allenamento di forza e resistenza degli arti superiori migliora la funzione delle braccia (**Evidenza B**)
- I benefici si estendono ben oltre l'immediato periodo di allenamento (**Evidenza B**)
- Migliora la sopravvivenza (**Evidenza B**)
- L'allenamento dei muscoli respiratori è di beneficio, specialmente se combinato con un allenamento fisico generico (**Evidenza C**)
- Migliora la ripresa dopo ricovero per una riacutizzazione (**Evidenza A**)[524]
- Aumenta l'effetto dei broncodilatatori a lunga durata d'azione (**Evidenza B**)

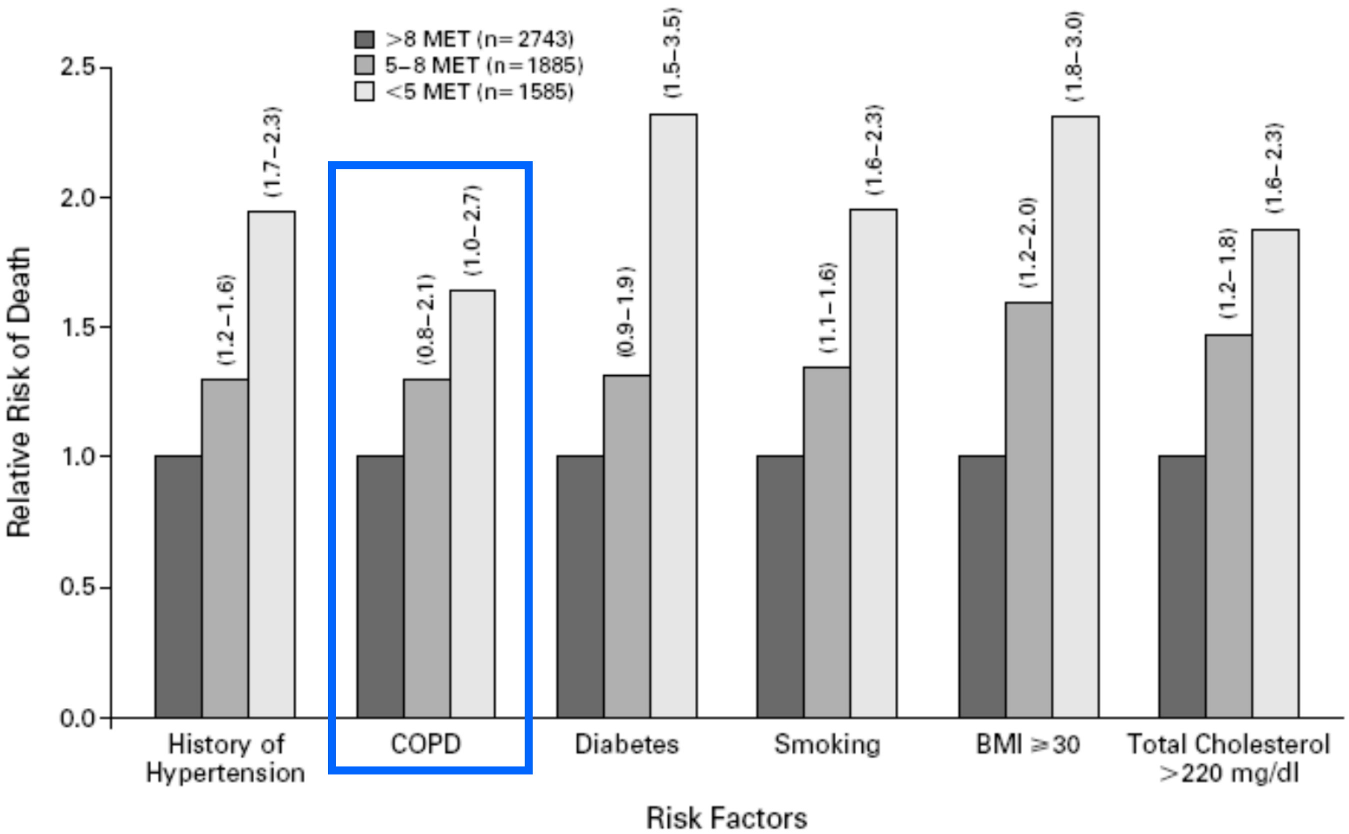
# Level of Physical Activity in COPD



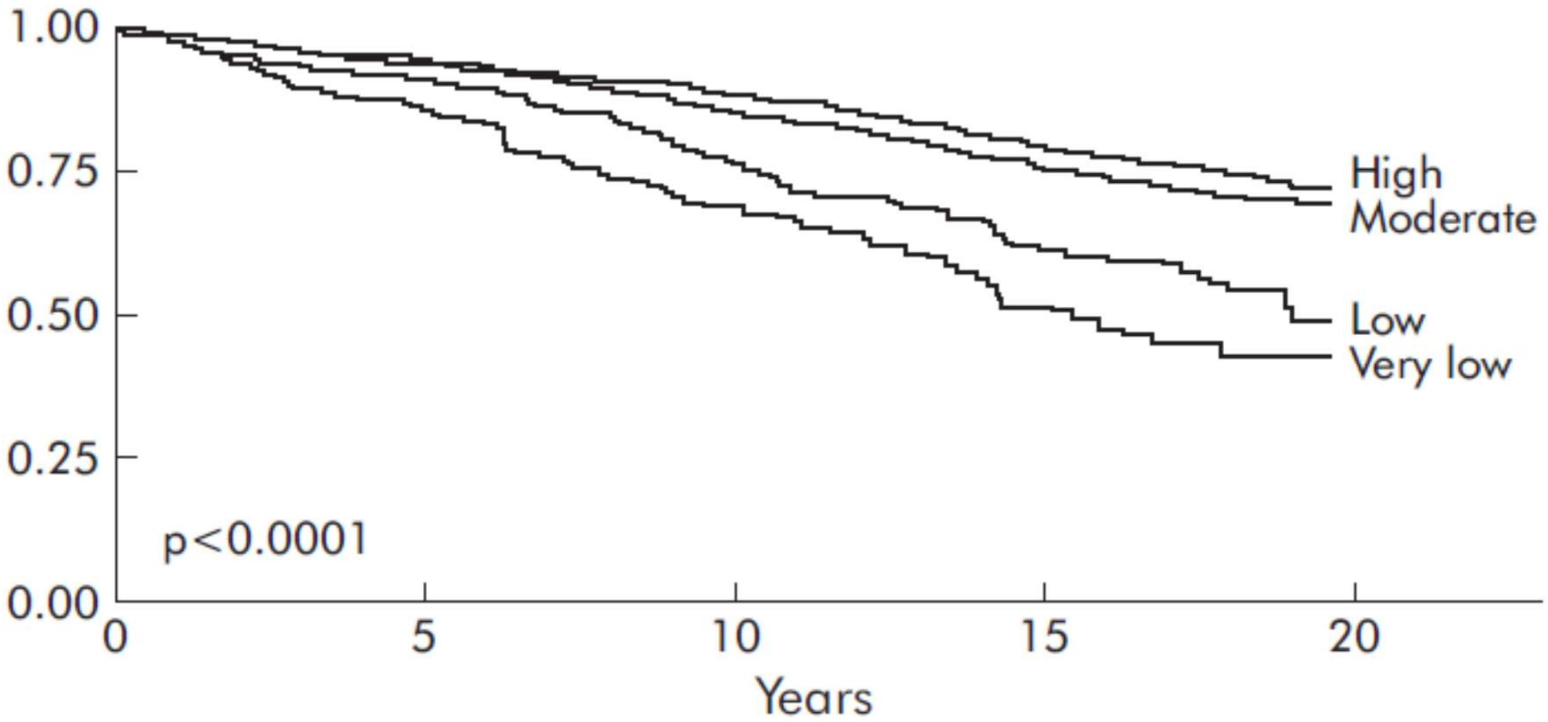

**Watz H, et al. ERJ 2009**

# EXERCISE CAPACITY AND MORTALITY AMONG MEN REFERRED FOR EXERCISE TESTING

JONATHAN MYERS, PH.D., MANISH PRAKASH, M.D., VICTOR FROELICHER, M.D., DAT DO, M.D., SARA PARTINGTON, B.SC., AND J. EDWIN ATWOOD, M.D.

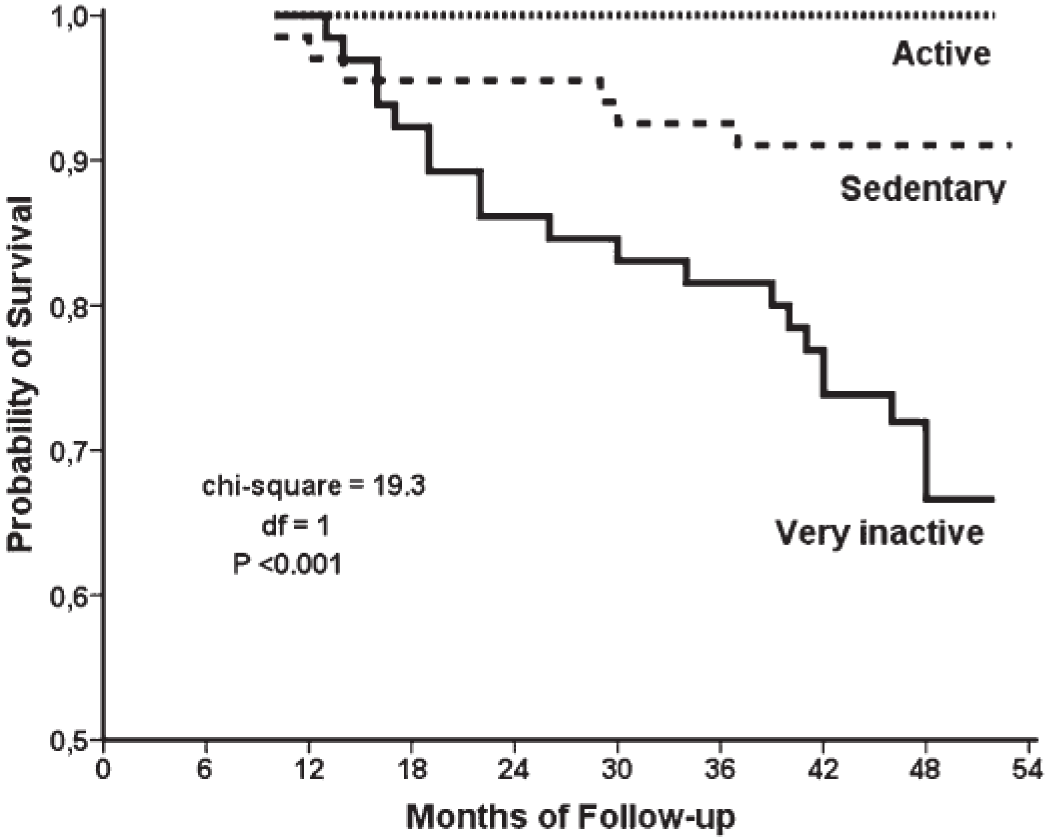


# COPD: physical inactivity and readmission




Garcia-Aymerich J, et al. Thorax 2

# COPD: physical inactivity and survival




**Waschki B, et al. Chest 201**

# Physical Activity assessment

Physical activity monitoring in COPD: Compliance and associations with clinical characteristics in a multicenter study☆

Respiratory Medicine (2012) 106, 522–530

Benjamin Waschki [a,*,h], Martijn A. Spruit [b,h], Henrik Watz [a], Paul S. Albert [c], Dinesh Shrikrishna [d], Miriam Groenen [b], Cayley Smith [d], William D.-C. Man [d], Ruth Tal-Singer [e], Lisa D. Edwards [f], Peter M.A. Calverley [c], Helgo Magnussen [a], Michael I. Polkey [d,i], Emiel F.M. Wouters [b,g,i]

*N* = **134 COPD** (GOLD II-IV, BODE 0-9) and **46 controls** in 3 north european centers

The excellent compliance with wearing a physical activity monitor irrespective of study site and consistent associations with relevant disease characteristics support the use as a valid outcome in multi-center studies

# Physical activity