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Aquatherapy in the pulmonary rehabilitation

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The three main diseases

- Chronic obstructive pulmonary disease – COPD
- Asthma bronchiale
- Cystic fibrosis - CF

Guidelines

Brithish ACPCF 2002 (physioth.)
Brithish COPD 2003 (med.)
Brithish Asthma 2005 (med.)

Holland COPD 2003 (physioth)
Hungarian COPD 2004 (med.)

COPD

- 4.-6. most frequent cause of death on the world
- Treatment with medicines is very expensive (2,5 x asthma br.) – not effective
- Prevalens
  - 900 000 (England) true number may be: 1,5 mill.
  - 54 000 (Hungary) – 4-500 000

Chronic bronchitis
Continuous airway obstruction
And productive cough
At least 3 mounts/yr - 2 successive yr

COPD

Emphysema
Increased lung volume
accompanied by destruction of alveolar walls
without fibrosis

Asthma bronchial

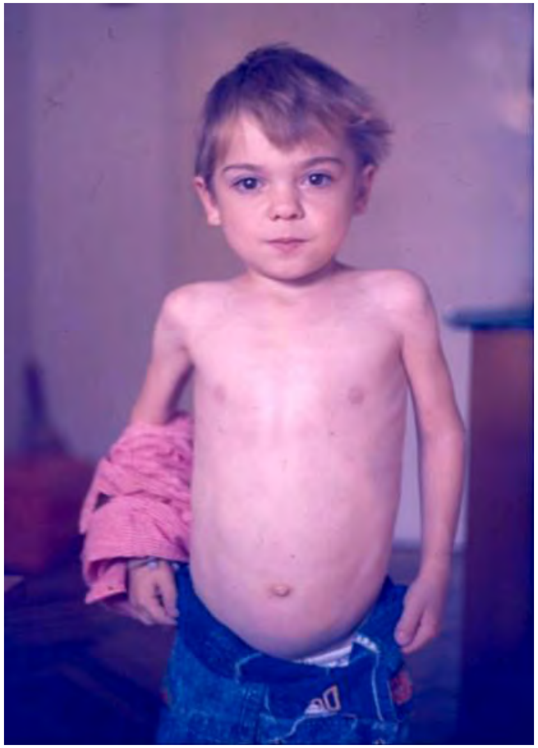
- Chronic inflammatory disorder of airways
- Airway obstruction
- Response to a variety of stimuli
  - Allergen – atopic
  - Exercise induced asthma - EIA
  - Psychogenic factors
- Reversibility - spontaneously or with treatment

Cystic fibrosis

- Genetic disorder with Ca^{++} channel problems – progressive and fatal

- Pulmonary features: multifarious lung image
  - Bronchitis (acute or chr.)
  - Emphysema
  - Fibrosis
  - Lot of mucus (dry and adhesive)

- Cor pulmonale
- Complex digestion insufficiency
    - Lack of proteins, carbohydrates, fats, vitamins, minerals



May be present

		COPD	ASTH.	CF
Dyspnoea	rest/exercise	+/+	+/+	+/+
Hyperinflated chest		+	+	+
Coughing		+	+	+
Wheeze or quiet breath sounds		+	+	+
Purse lip breathing		+	+	+
Use of accessory muscles		+	+	+
Paradox movement of lower ribs		+	+	+
Peripheral oedema		+	+	+
Decreased physical condition		+	+	+
Depression- socially isolated		+	+	+

Causes

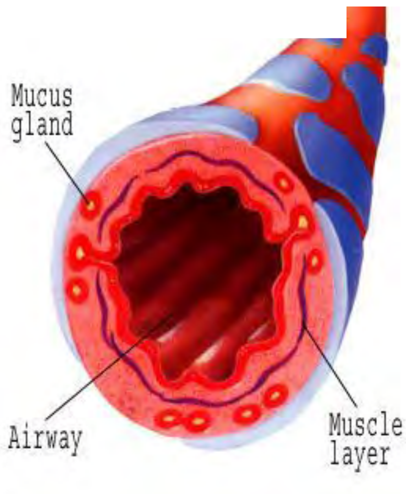
	COPD	ASTH.	CF
• Smoking (10-15% of COPD patients have never smoked*)	+	+	-
• Genetic predisposition	+	+	+
• Hypersensitivity – allergens	+	+	-
• Respiratory infections	+	-	-

*Fletcher C, Peto R: The natural history of chronic airflow obstruction. BMJ 1:1645-1648, 1977

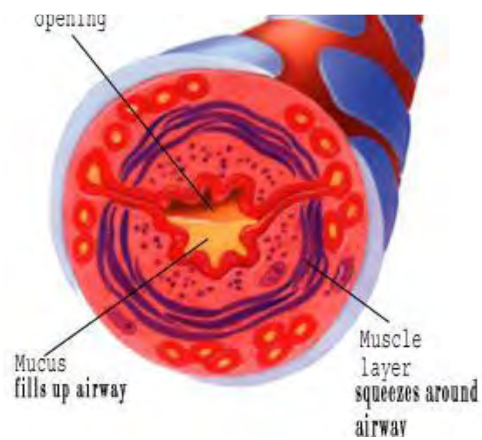
Noisy breathing

Because of airway obstruction:

Reversible or not



Normal airway



Obstructed airway

Dyspnea

- Dyspnoea
  - longer expiration > 6s
  - Hard expiration
  - Hard inspiration
  - In rest or effort
  - Position supported breath
  - Pursed-lips breathing

(auto PEP)

Failure of respiratory system

- Chest deformity – hyperinflation
- Horizontal ribs position
- Shortened intercostals muscles
- Deep position of the diaphragm
- Decreased ROM of ribs - rigid thorax

➡ Increased energy requirement of expiration and inspiration

barrel

Tables of Moses

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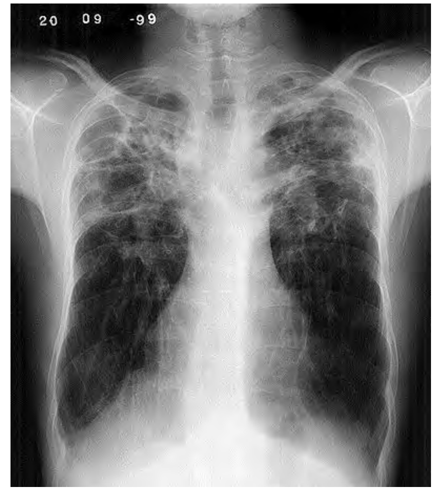
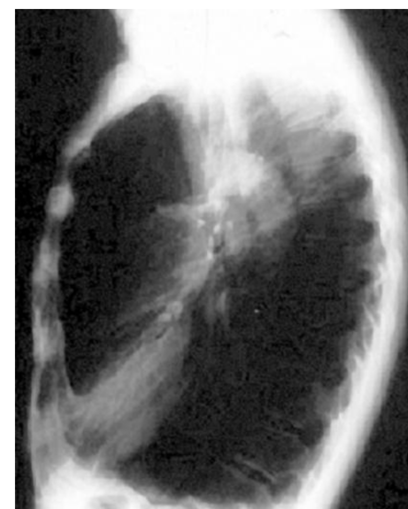
Normal Asthma CF COPD





Thorax

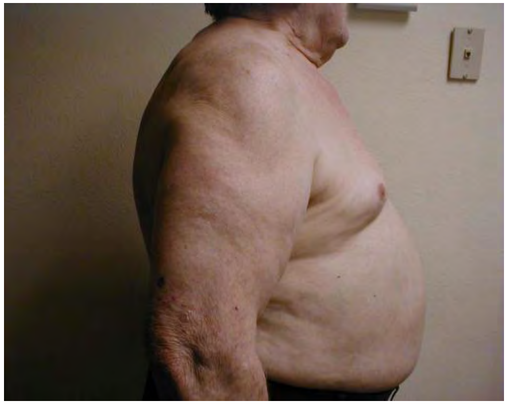
CF: 12 Year old boy

Hyperinfated chest in exacerbation

The chest after treatment (with PEP)

Young adult CF boy: Improved kyphosis, and visible accessory breathing muscles

4 year old child: ensconced costochondral area



COPD bronchiatic form
Hyperinflated chest
shortened neck,
overweight

Lung function

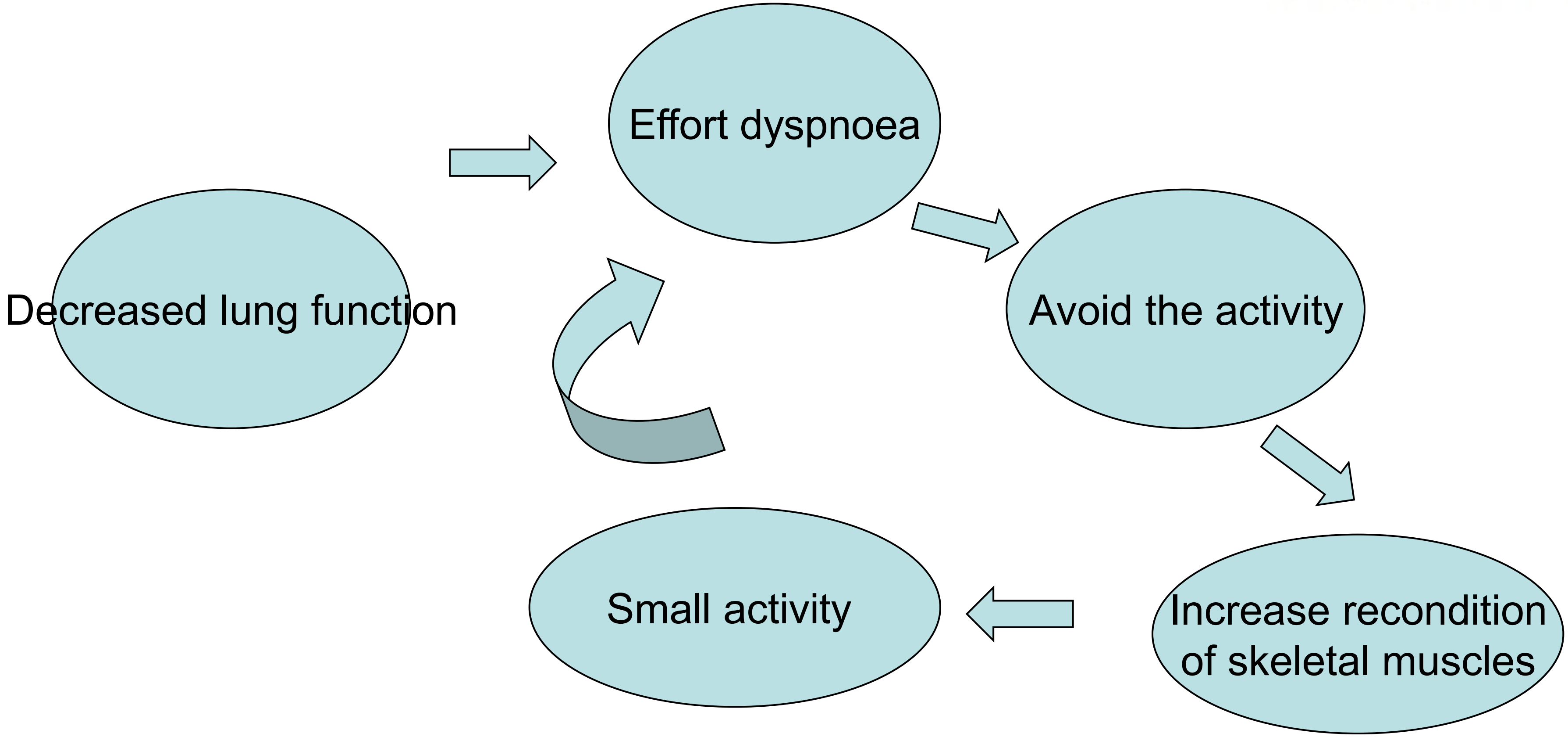
- COPD: not typical
  - FEV1 ↓ > 80% of pred.   ↓50 ml/yrs (norm: 25-30)
  - FEV1/FVC↓ 70-30% (norm≈80%)
- Asthma: (in attack)
  - FEV1 ↓↓
  - FVC norm or ↓
  - FEV1/FVC ↓↓↓   PEF ↓↓
- CF: variable
  - RV ↑↑↑ (maybe obstructive + restrictive too)

COPD classification

FEV1 (% of predicted value)

- European Respiratory Society
  - mild ≥ 70%
  - moderately severe 50–69%
  - severe 35–49%
- American Thoracic Society
  - phase 1 ≥ 50%
  - phase 2 35–49%
  - phase 3 < 35%

Decreased physical activity



American Thoracic Society/European Respiratory Society: Skeletal muscle dysfunction in chronic obstructive pulmonary disease. Am. J. Respir. Crit. Care Med. 159:S1-S40, 1999

Muscle fatigue is caused by

- the effort dyspnoea
- reduced aerobic capacity
  *(Fiber I decreases, Fiber IIa increases)
- lactic acid increased at an earlier stage during exercise
- cardiac decompensation
- corticosteroid use
- impaired nutritional stage
- **Montes de Oca et al Respiratory Medicine (2006) 100, 1800–1806*

Goals of the physiotherapy

- to improve mucus clearance;
- to improve exercise capacity;
- to reduce dyspnoea; and
- to promote compliance with therapy.

Expectoration

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- Increase the viscosity of mucus of airways
- Increase the airflow during expiration
- Increase the airway diameter (prevent the collapse, decrease the obstruction)
- Increase the effectivity of cough

Mucolytics AT FET Clapping shaking
PD Huffing
ACBT PEP external pressure

Respiratory Physiotherapy

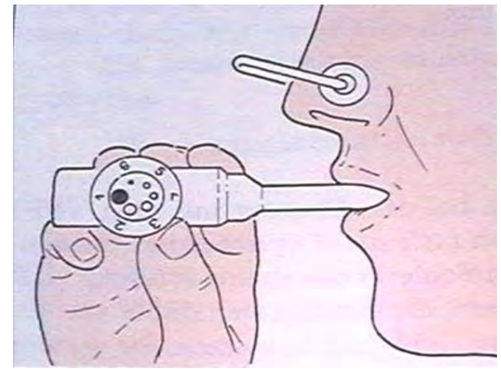
- has three main aims:
  - To help reduce the work of breathing associated with respiratory disease
  - To help restore patients' maximal function
  - To help improve peripheral and respiratory muscle weakness

Core treatments delivered by physiotherapists include:

- Techniques to reduce the work of breathing
  - relaxed breathing control in combination with positioning to maximise the function of the respiratory muscles and enhance diaphragmatic displacement.
  - In chronic asthma, the use of diaphragmatic breathing has shown a significant benefit on health related quality of life.
  - Pursed Lip Breathing techniques may be effective in helping patients manage breathlessness although data is limited.

Positive expiratory pressure

- 10–20 cmH2O
- respiratory tract dilatation caused by increased expiratory airway pressure
- Flutter + airway vibration are thought to improve mucus transport.

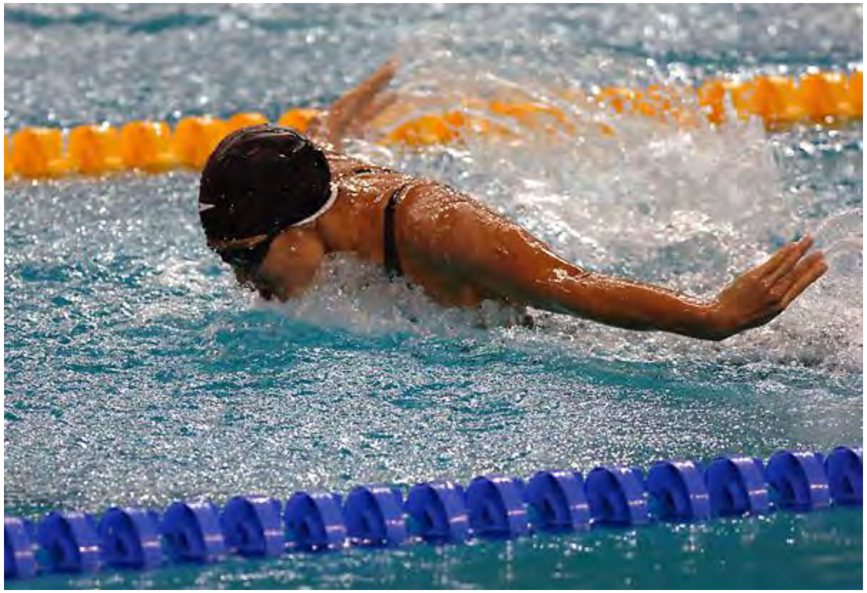


PEP in water

Blowing bubbles

Breath control

Expiration under water during swimming



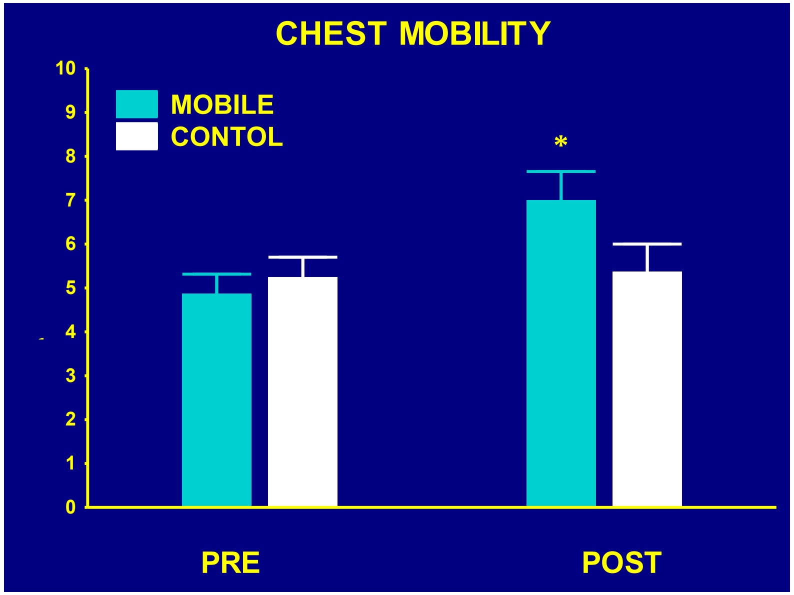
Mobilization of the thorax

Manual mobilization
Active movements
Stretching
Flutter

Mobilization of the thorax

16 patients with COPD

(mean aged: 60,1 years, 48-77)



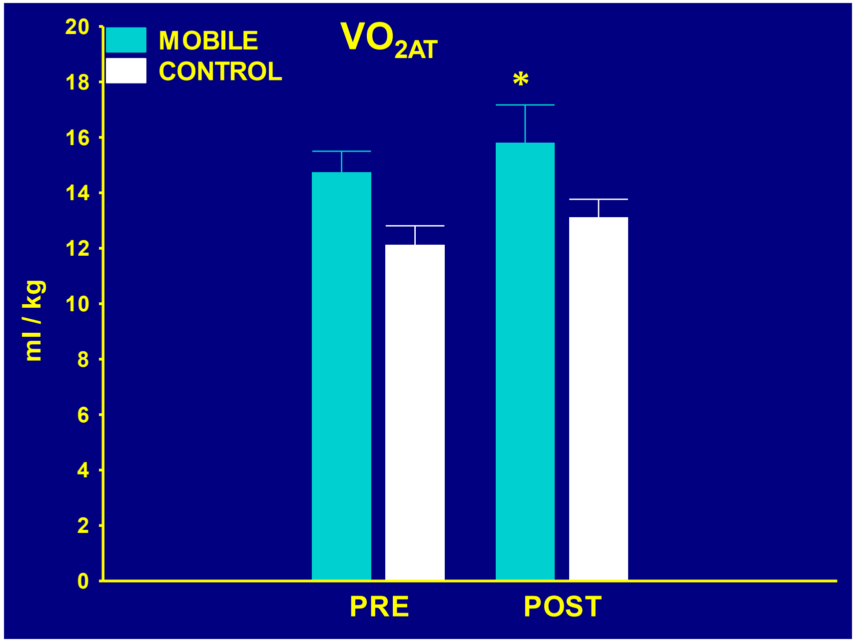
Barnai et al Barcelona WCPT Congr. 2003

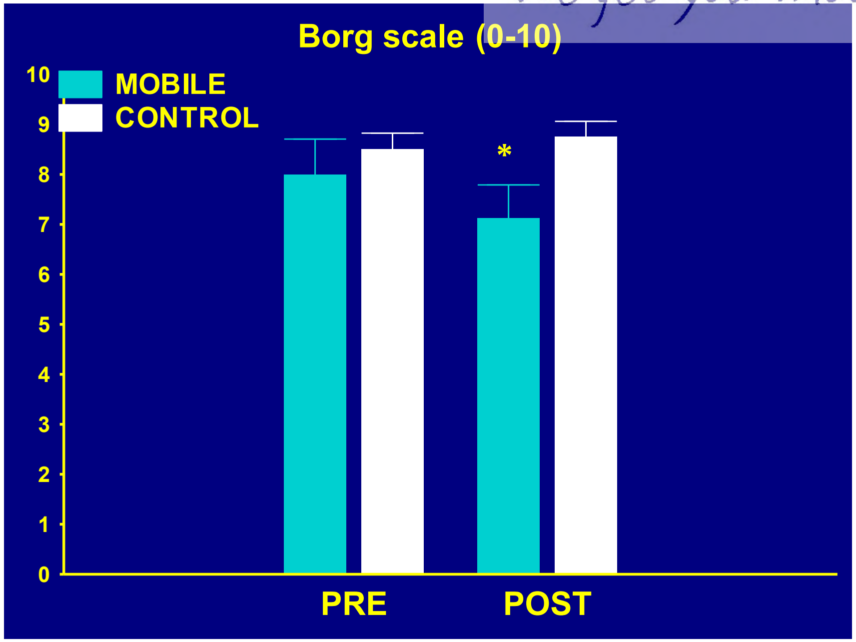
Cycle ergometer training for both groups

- 3 times a week for 8 weeks
- daily session: 40 minutes

	FEV1 % pred	Tiff (FEV1/VC)
Mobilized G (n=8)	41 - 64	43 - 49
Control G (n=8)	34 - 68	39 - 66

Mobilization of the thorax





Improvement of the mobility of the thorax has a favourable influence on the exercise tolerance and fatigue without significantly influencing the results of the lung function, and peak oxygen consumption.

Barnai et al Barcelona WCPT Congr. 2003

Chest mobilization in Water

- Water gives an external pressure (hydrostatic) to
  - Chest wall
  - Abdomen → diaphragm
  - ↓
  - Deeper expiration → deeper inspiration
  - Reduced RV
  - Strengthening of the inspiratory muscles
  - + active expiration against the resistance of the water

The water optimizes the diaphragm function

- Elongates of the low positioned diaphragm:
  - contraction of the abdominal muscles during expiration
  - hydrostatic pressure on the wall of abdomen

- Gives a resistance against the expiration
- This action facilitates the diaphragm function. The next inspiration start from a better diaphragm position

The accessory muscles of respiration can provide more force if the arms are anchored in position, for example during swimming

Chest mobilization in water

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Chest mobilization in Water

Effect of dry and humid air

- EIA – dry inhaled air provoke the asthmatic airway reaction during exercise

Study: 9 asthmatic children (9-15 years old)

- Treadmill running | Swimming exercise

Bronchoconstriction | No bronchoconstriction

Humidity: 25-30% | 80-90%

conditions were same: intensity, duration, temperature of air, and water

- *Inbar Eur J Appl Physiol 1980*

Main points of treatment for improving exercise capacity.

- A good breathing technique is necessary for training to build exercise capacity.
- Functions that are important for physical performance :
  - muscle strength,
  - muscle endurance,
  - speed,
  - coordination
  - and flexibility.

Type of exercise

- circuit training,
- sports and games,
- Swimming or exercise in water

- Patient become more active and independent

Measurement

- strength and endurance of skeletal muscles with dynamometer
- respiratory muscles: strength and endurance measurement with mouth pressure meter
- general endurance measurement:
  - 6 or 12 minute walking test (MWT), shuttle walk test,
  - cycle ergometer / treadmill endurance test
  - Borg scale
- dyspnoea: dyspnoea scale

Dyspnoea scale

Grade Degree of breathlessness related to activities

- 1 Not troubled by breathlessness except on strenuous exercise
- 2 Short of breath when hurrying or walking up a slight hill
- 3 Walks slower than contemporaries on the level because of
- breathlessness, or has to stop for breath when walking at own
- pace
- 4 Stops for breath after walking about 100m or after a few
- minutes on the level
- 5 Too breathless to leave the house, or breathless when
- dressing or undressing

- (Fletcher CM et al. 1959)

Effects of physical activity in COPD

Author	Study design	*n*	Studied parameters	Significant results
Cambach *et al*[10] (Netherlands)	RCT	23	Exercise tolerance (CE, 6MWT), QOL (CRQ), dyspnoea (CRQ)	Improved exercise tolerance (CE, not 6MWT), QOL and dyspnoea after three months, and again three months later (CE and 6MWT), QOL and dyspnoea
Clark *et al*[11] (UK)	RCT	48	Exercise tolerance (CE, WT)	Improved exercise tolerance after three months (WT, not CE)
Clark *et al*[12] (UK)	RCT	43	Exercise tolerance (WT)	Improved exercise tolerance after three months (WT)
Grosbois *et al*[13] (France)	CCT	58	Exercise tolerance (CE), dyspnoea (VAS)	Improved exercise tolerance in subgroups after 18 months (CE); no difference in dyspnoea
Ringbaek *et al*[14] (Denmark)	RCT	38	Exercise tolerance (6MWT), dyspnoea (BS), QOL (SGRQ, PWBI)	No effects on exercise tolerance, dyspnoea or QOL after two months

CE = cycle ergometry (physiological parameters, maximal exertion in watts); 6MWT = six-minute walking test (distance in metres); WT = walking test (endurance in joules); CRQ = chronic respiratory disease questionnaire (including dyspnoea score); SGRQ = St George's respiratory questionnaire; PWBI = psychological wellbeing index; VAS = visual analogue scale; BS = Borg scale.

Chavannes et al *British Journal of General Practice,* 2002

Asthma and swimming

Eight children with mild or moderate asthma participated in swimming training every days for six weeks.

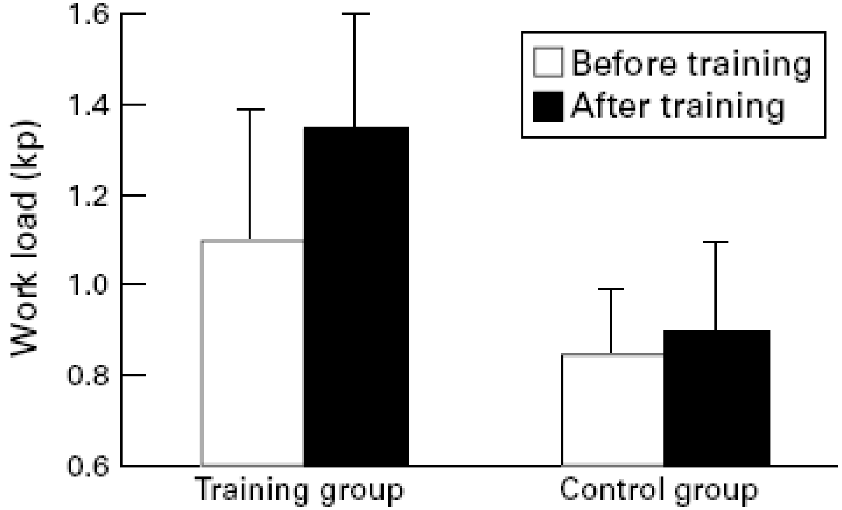

Figure 3 Mean (SD) changes in work load by swimming ergometer before and after training in training group (n = 8) and control group (n = 8).

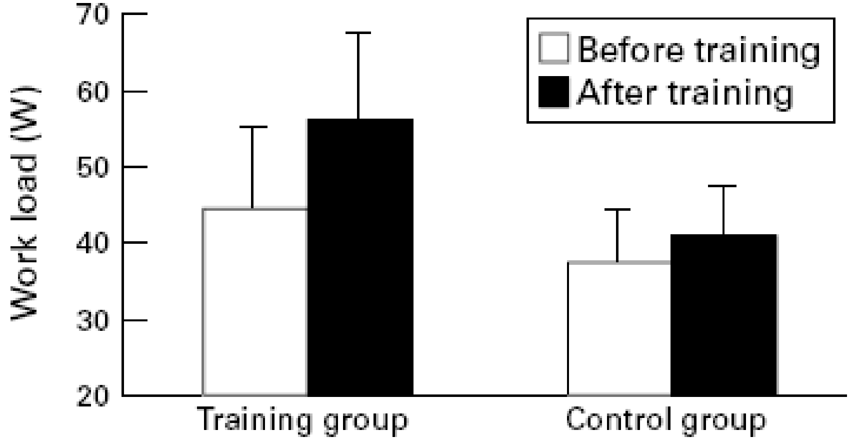

Figure 4 Mean (SD) changes in work load by cycle ergometer before and after training in training group (n = 8) and control group (n = 8).

Matsumoto et al Thorax 1999;54;196-201

Improve the physical activity and exercise tolerance

- Mild and moderate asthma br.
- Swimming: 3 years - two times a week
- Results of Cooper test 12 min running:

	number	age	12min running
Swimmer/ asthmatic	51	8-22	2358,4 m (± 400,6)
Not sw./ asthmatic	28	9-22	2214,5 m (± 426,6)
Not sw./ healthy	179	8-22	1850,8 m (± 408,3)

- *Bellanyi, Gyene et al (2007 Orvosi hetilap)*

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Cardiorespiratory parameters at rest on land and in water (n=20) COPD

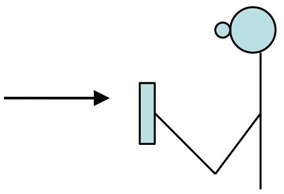
Parameter	Land	Water	p-value
HR beats/min	82±22	86±18	NS
SBP mmHg	164±17	150±18	<0.001
DBP mmHg	87±10	81±11	0.01
Ventilation breaths/min	18.5±4.3	18.5±5.2	NS
*S*a,O2 %	94±4	94±4	NS
VC L	2.19±0.78	1.92±0.79	<0.001
FEV1 L	1.08±0.53	0.93±0.54	<0.001
FEV1/VC	0.51±0.12	0.48±0.13	NS
PEF L/min	120±82	99±83	<0.001

J Perk et al Eur Respir J., 1996, 9, 248–252.

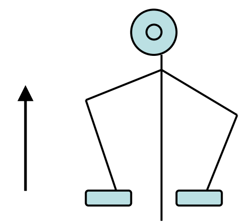
Parameters during 15 min dynamic submaximal arm exercise on land and in water (n=20) COPD

	Land	Water	p-value
Heart rate (HR)beats/min			
Exercise I	111±22	115±20	NS
Exercise II	119±25	116±21	NS
ExerciseIII	114±24	115±23	NS
ΔResting HR	13±9	7±6	<0.05
***Sa*,O2 %**			
Exercise I	93±5	93±4	NS
Exercise II	95±4	93±3	<0.05
Exercise III	94±4	94±3	NS
Borg rating of effort			
Exercise I	12±2	14±2	0.01
Exercise II	15±2	15±2	NS
Exercise III	14±2	14±3	NS
Borg rating of dyspnoea			
Exercise I	3±1	4±1	<0.01
Exercise II	4±1	5±2	<0.01
Exercise III	4±2	4±1	NS

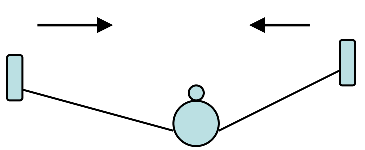
J Perk et al Eur Respir J., 1996, 9, 248–252.



Rowing



lifting

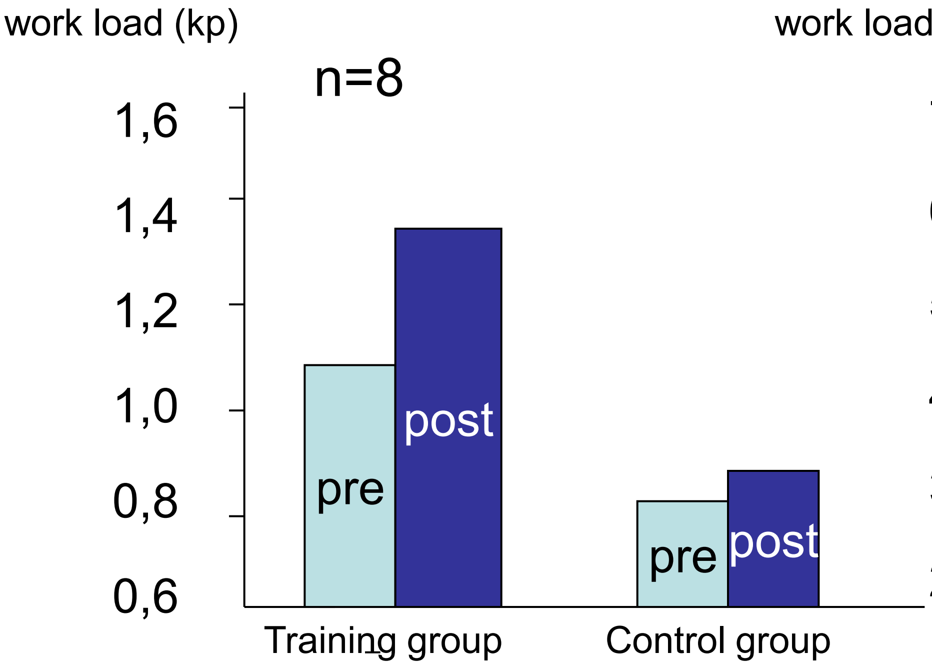


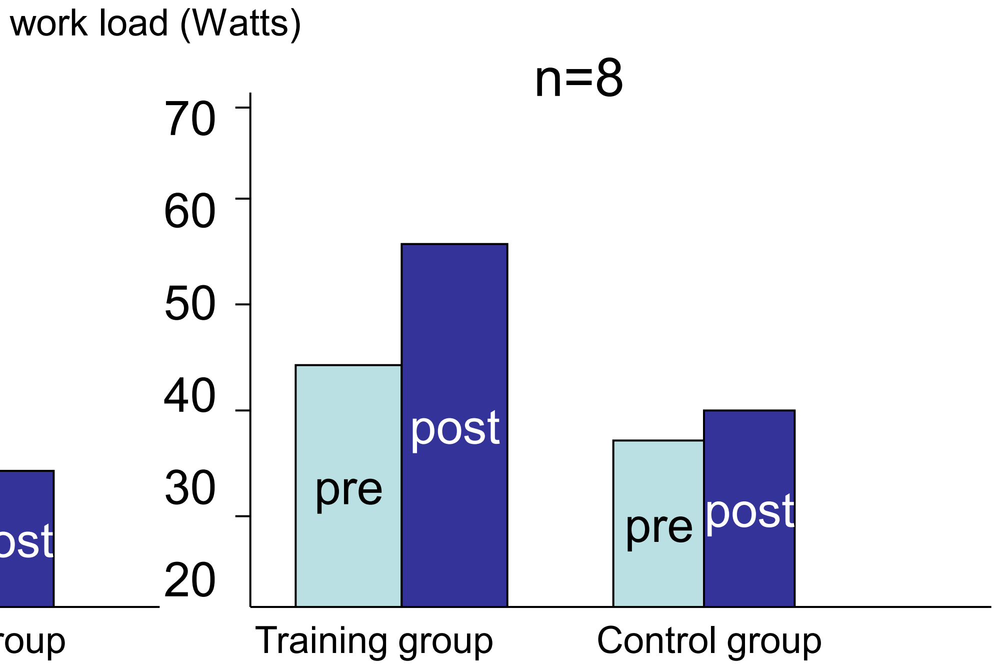
Horizontal weight pulling

3/2min

Effects of swimming training

Training on the swimming ergometer - high intensity
2*15 min/day * 6 day /week * 6 week



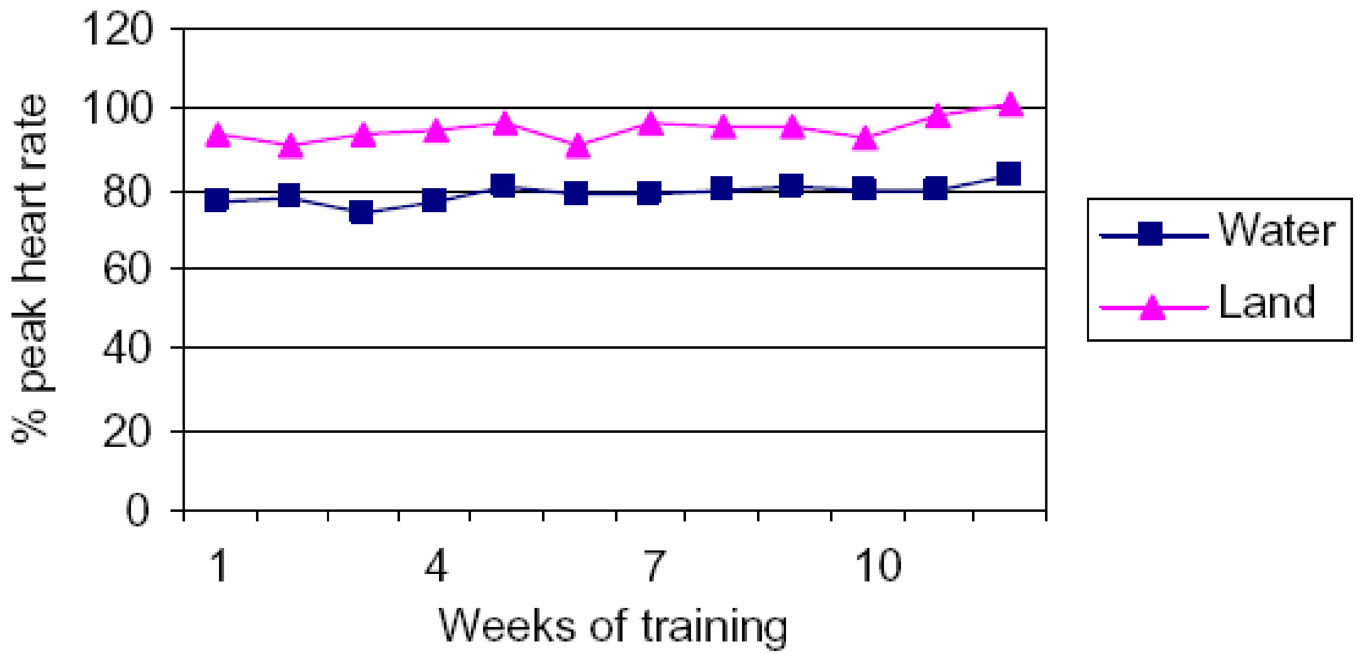


- **Swimming ergometer** **cycling ergometer on land**

- *Tanaka and M Shindo et al (Thorax* 1999;54;196-201)

Training of COPD on land and water

High intensity physical group training in water (water group) or on land (land group) was performed for 12 weeks, three times per week, 45 min per session



Wadell et al Respiratory Medicine (2004) 98, 428–438

Incremental shuttle walk test
Endurance shuttle walk test (COPD)

		Control group	Water group		Land group		
		(n = 12)	Intention to treat (n = 15)	On treatment (n = 12)	Intention to treat (n = 14)	On treatment (n = 12)	Between group comparisons
ISWT (m)	Baseline	345 (180–550)	270 (200–540)	270 (200–540)	350 (130–570) ★	380 (130–570) ★	ns
	3 months	320 (200–500)	340 (150–540)	345 (260–540)	390 (140–590)	420 (140–590)	
	Within group comparison	ns	ns	ns	$P = 0.008$	$P = 0.003$	
	Difference Baseline/3 mo	−5 (−110–80)	20 (−140–110)	55 (−90–110)	20 (−20–130)	25 (0–130)	$P = 0.03$[a] $P = 0.008$[b]
ESWT (m)	Baseline	1047 (116–1538)	458 (133–1364) ★	562 (133–1364) ★	576 (85–1905)	686 (85–1905)	ns
	3 months	599 (176–1446)	1060 (315–1846)	1319 (315–1846)	512 (209–1905)	747 (209–1905)	
	Within group comparison	ns	$P = 0.001$	$P = 0.002$	ns	ns	
	Difference Baseline/3 mo	−40 (−890–444)	164 (8–1454)	179 (8–1454)	53 (−473–704)	53 (−473–704)	$P = 0.001$[c] $P = 0.009$[d] $P = 0.001$[e] $P = 0.007$[f]

Wadell et al Respiratory Medicine (2004) 98, 428–438

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		Control group	Water group		Land group		
		(n = 12)	Intention to treat (n = 15)	On treatment (n = 12)	Intention to treat (n = 14)	On treatment (n = 12)	Between group comparisons
Time cycled (s)	Baseline	495 (230–1260)	520 (360–720)	520 (380–720)	540 (260–1170)	540 (350–1170)	ns
	3 months	525 (240–1440)	580 (380–900)	595 (390–900)	575 (270–1300)	595 (390–1300)	
	Within group comparison	ns	$P = 0.004$	$P = 0.008$	$P = 0.033$	$P = 0.016$	
	Difference Baseline/3 mo	20 (−110–180)	40 (−30–180)	85 (−30–180)	25 (−50–170)	40 (−30–170)	ns
$Load_{peak}$ (W)	Baseline	60 (40–140)	60 (40–80)	60 (60–80)	60 (40–140)	60 (40–140)	ns
	3 months	60 (40–160)	80 (60–100)	80 (60–100)	80 (40–160)	80 (60–160)	
	Within group comparison	$P = 0.046$	$P = 0.008$	$P = 0.014$	$P = 0.008$	$P = 0.008$	
	Difference Baseline/3 mo	0 (0–20)	0 (0–20)	10 (0–20)	10 (0–20)	20 (0–20)	ns
$VO_{2\ peak}$ (ml/kg·min)	Baseline	16.6 (10.8–24.9)	15.6 (13.0–23.1)	15.5 (13.2–23.1)	17.7 (13.3–27.3)	18.9 (14.6–27.3)	ns
	3 months	18.0 (11.5–28.7)	16.9 (14.0–26.4)	16.9 (14.0–26.4)	17.7 (13.3–34.1)	19.8 (13.9–34.1)	
	Within group comparison	$P = 0.018$	$P = 0.008$	$P = 0.004$	ns	ns	
	Difference Baseline/3 mo	0.7 (−0.7–3.8)	1.5 (−1.9–3.5)	2.1 (−0.5–3.5)	0.6 (−3.9–6.8)	0.6 (−3.9–6.8)	ns