Exercise Interventions in Patients with Chronic Obstructive Pulmonary Disease
C.O.P.D.: Definition

COPD is characterised by:

- Chronic Obstructive Bronchitis (COB)
- Emphysema with an Obstruction
- Chronic Bronchitis and Emphysema with an asthmatic Component
Mortality rates in the U.S.A. in %
(1965 – 1998)

Proportion of 1965 Rate

- Coronary Heart Disease: -59%
- Stroke: -64%
- Other CVD: -35%
- COPD: +163%
- All Other Causes: -7%
Worldwide Mortality Trends
– The 10 most common causes –

<table>
<thead>
<tr>
<th>Diseases 1990</th>
<th>Diseases 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Coronary Heart Disease</td>
<td>◆ Coronary Heart Disease</td>
</tr>
<tr>
<td>◆ Stroke</td>
<td>◆ Stroke</td>
</tr>
<tr>
<td>◆ Pneumonia</td>
<td>◆ COPD</td>
</tr>
<tr>
<td>◆ Diarrhoea</td>
<td>◆ Pneumonia</td>
</tr>
<tr>
<td>◆ Baby mortality</td>
<td>◆ Lung cancer</td>
</tr>
<tr>
<td>◆ COPD</td>
<td>◆ Road traffic accidents</td>
</tr>
<tr>
<td>◆ Tuberculoses</td>
<td>◆ Tuberculoses</td>
</tr>
<tr>
<td>◆ Chicken Pocks</td>
<td>◆ Gastric carcinoma</td>
</tr>
<tr>
<td>◆ Road traffic accidents</td>
<td>◆ HIV / AIDS</td>
</tr>
<tr>
<td>◆ Lung cancer</td>
<td>◆ Suicide</td>
</tr>
</tbody>
</table>

Approx. 12-15% of all adults in the UK suffer from COPD!
Chronic Obstructive Pulmonary Disease [COPD]

non-smoker’s lung

smoker’s lung
Aetiology: COPD

90% smoking cigarettes

90% air pollution
many bronchial infection

10% early birth
α1-Antitrypsine deficit
....
Pulmonary Function Diagnostics
Flow-Volume-Diagram of an Asthma-Patient

Flow % norm

Volume % norm
Flow-Volume-Diagram of a COPD-Patient
# Asthma or COPD?

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Asthma</th>
<th>COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>childhood / youth</td>
<td>&gt; 40 years</td>
</tr>
<tr>
<td>Tobacco</td>
<td>non-smoker &gt; smoker</td>
<td>smoker</td>
</tr>
<tr>
<td>Symptoms @ night</td>
<td>attacks of dyspnoea</td>
<td>exercise dyspnoea</td>
</tr>
<tr>
<td>Allergy</td>
<td>often</td>
<td>rarely</td>
</tr>
<tr>
<td>Progression</td>
<td>variable</td>
<td>progressive</td>
</tr>
<tr>
<td>Obstruction</td>
<td>variable</td>
<td>persisting</td>
</tr>
<tr>
<td>Reversibility</td>
<td>&gt; 20 % (FEV&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>&lt; 15 % (FEV&lt;sub&gt;1&lt;/sub&gt;)</td>
</tr>
<tr>
<td>Hyper reactivity</td>
<td>regularly</td>
<td>sometimes</td>
</tr>
<tr>
<td>Response to Cortisone</td>
<td>regularly</td>
<td>sometimes</td>
</tr>
<tr>
<td>Mucus</td>
<td>little</td>
<td>much</td>
</tr>
</tbody>
</table>

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**Introduction**

**Prevalence**

**Pathophysiology**

**Research**

**Methodology**

**Results**

**Summary**

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# Classification of COPD

<table>
<thead>
<tr>
<th>Stage</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV (final stage)</td>
<td>FEV(_1/)VC ≤ 70%, or FEV(_1) &lt; 50% normal or FEV(_1) &lt; 50% normal FEV(_1) ≤ 30% normal + respiratory failure + symptoms of CHF</td>
</tr>
<tr>
<td>III (severe)</td>
<td>FEV(_1/)VC ≤ 70%, 30% &lt; FEV(_1) ≤ 50% normal +/- chronic symptoms (coughing, sputum, dyspnoea)</td>
</tr>
<tr>
<td>II (medium)</td>
<td>FEV(_1/)VC ≤ 70%, 50% &lt; FEV(_1) ≤ 80% normal +/- chronic symptoms (coughing, sputum, dyspnoea)</td>
</tr>
<tr>
<td>I (slight)</td>
<td>FEV(_1/)VK &lt; 70%, FEV(_1) &gt; 80% normal +/- chronic symptoms (coughing, sputum, breathing difficulties during exercise)</td>
</tr>
<tr>
<td>0 (risk)</td>
<td>Normal pulmonary function + symptoms (coughing, sputum)</td>
</tr>
</tbody>
</table>


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Catabolic state of COPD-Patients

- Reduced contractility
- Insulin resistance
- Reduced testosterone
- Reduced IGF-1

Muscle atrophy

- Negative energy balance
- Hypoxemia
- Steroid treatment
- Systemic inflammation

Exercise intolerance

Reduced health status

Sorichter. MedReport; (7) 13, 2004
## Effects of Out-Patient Rehab Programmes in COPD-Patients

<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention</th>
<th>Effects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author (J)</strong></td>
<td><strong>n</strong></td>
<td><strong>Type</strong></td>
<td><strong>Duration (weeks)</strong></td>
</tr>
<tr>
<td>Vogiatzis (2005)</td>
<td>36</td>
<td>T</td>
<td>12</td>
</tr>
<tr>
<td>Emtner (2003)</td>
<td>28</td>
<td>T</td>
<td>7</td>
</tr>
<tr>
<td>Wright (2002)</td>
<td>40</td>
<td>T</td>
<td>12</td>
</tr>
<tr>
<td>Troosters (2000)</td>
<td>37</td>
<td>T</td>
<td>26</td>
</tr>
<tr>
<td>Grüell (2000)</td>
<td>30</td>
<td>T, N, P</td>
<td>52</td>
</tr>
<tr>
<td>Grosbois (1999)</td>
<td>44</td>
<td>T, P, S</td>
<td>7</td>
</tr>
<tr>
<td>Foglio (1999)</td>
<td>26</td>
<td>T, S, N, PC</td>
<td>8</td>
</tr>
</tbody>
</table>

**n**: Number of subjects  
**HRQL**: Health related quality of life  
**H**: Hospitalisation  
**T**: Training  
**P**: Physiotherapy  
**S**: Seminars  
**N**: Nutrition  
**PC**: Psycholog. counselling

### Introduction

- Prevalence
- Pathophysiology
- Research
- Methodology
- Results
- Summary
Effects of a high intensity strength training on:

1. Physiological parameters such as strength, endurance, testosterone ….
2. Health related quality of life and
3. Pulmonary parameters.
Study Design

• 12 weeks intervention; 3 sessions of exercise therapy/week
• 4 Visits and/or test points
• Test battery:
  – clinical assessment
  – pulmonary function test
  – performance analysis (endurance, strength)
  – testosterone analysis
  – questionnaires: symptoms, depression profile, stress coping
Intervention

Warm up:

- Cycle ergometer
- Joint cycling
- Standing press ups
Intervention

Strength exercises:

- Leg press
- Leg curl
- Bench press
Intervention

Strength exercises:

- Lat-Pull
- Rowing seated
- Back extension
- Abdominal press
Changes in Strength in Percentage

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg press</td>
<td>41</td>
<td>40.1</td>
</tr>
<tr>
<td>Leg curl</td>
<td>32.1</td>
<td>35.2</td>
</tr>
<tr>
<td>Bench press</td>
<td>35.2</td>
<td>33.8</td>
</tr>
<tr>
<td>Lat pull</td>
<td>39.1</td>
<td>39.1</td>
</tr>
<tr>
<td>Rowing seated</td>
<td>-5</td>
<td>5</td>
</tr>
<tr>
<td>Back extension</td>
<td>-5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>45</td>
</tr>
</tbody>
</table>

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Introduction  Prevalence  Pathophysiology  Research  Methodology  Results  Summary
Cycle Ergometry: Absolute Performance

Introduction       Prevalence       Pathophysiology       Research       Methodology

Results

Summary

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Performance @ 4 mmol/L Blood Lactate Concentration

![Graph showing Performance @ 4 mmol/L Blood Lactate Concentration]

- **Baseline test**
  - Treatment group: 70 Watts
  - Control group: 70 Watts

- **Retest**
  - Treatment group: 80 Watts
  - Control group: 70 Watts

**Legend:**
- ■ Treatment group
- □ Control group
FEV₁ Performance

Intervention Group

Control Group

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Mean Peak-Flow Performance in the Morning over 14 weeks in the Intervention and the Control Group

**Graph:**
- **Y-axis:** Peak Flow Value [L]
- **X-axis:** Weeks
- **Lines:**
  - Intervention Group
  - Control Group
  - Trend line Intervention
  - Trend line Control

**Equations:**
- Intervention Group: \( y = 0.1226x + 251.51 \)
- Control Group: \( y = 0.0503x + 244.56 \)

**R² Values:**
- Intervention Group: 0.2135
- Control Group: 0.0236

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Mean Peak-Flow Performance in the Evening over 14 weeks in the Intervention and the Control Group

\[ y = 0.0167x + 277.42 \]
\[ R^2 = 0.0024 \]

\[ y = 0.1879x + 269.76 \]
\[ R^2 = 0.5464 \]
Changes in Blood Testosterone Concentration

**Graph:**
- **Y-axis:** Total testosterone blood concentration [ug/l]
- **X-axis:** Time
- **Baseline Test** vs **Retest**
- **Legend:**
  - Red: Treatment group
  - Black: Control group

**Table**

<table>
<thead>
<tr>
<th>Time</th>
<th>Treatment group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Test</td>
<td>3.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Retest</td>
<td>3.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**Discussion**

- **Introduction**
- **Prevalence**
- **Pathophysiology**
- **Research**
- **Methodology**
- **Results**
- **Summary**
Health Related Quality of Life

Introduction       Prevalence       Pathophysiology       Research       Methodology

Results

Summary

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Summary

- The literature suggests that any exercise intervention has a positive effect on health relevant parameters.

- A high intensity strength training over 12 weeks is safe and effective in COPD patients stage 2-3.

- The intervention produced significant increases in strength and endurance.

- It also lead to significant improvements in FEV$_1$, but not in other pulmonary parameters.

- The intervention increased the absolute testosterone blood concentration, which might be useful in the treatment of the disease specific reduction of anabolic hormones in male COPD patients [???].

- A significant improvement in HRQL in the intervention group could be shown between the pre tests and post intervention tests.
Summary

And now let's do some phys.

You are welcome... and when you ever want to get rid of a smoker: give me a shout.
Exercise Interventions in Patients with Chronic Obstructive Pulmonary Disease
COPD Symptom Cycle

- limited physical capacity of COPD-patients
  - obstruction
  - gaseous exchange ↓
  - pulmonary hypertension
  - dysfunction of skeletal muscles
  - breathing muscles ↓
  - SV ↓
Risks of activity related dyspnoea in obstructive pulmonary diseases

Dyspnoea during exercise and/or physical activity

Physical inactivity

De-conditioning of the cardiovascular system and muscles

Reduced quality of life

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Intrinsic Asthma vs. Extrinsic Asthma: Allergic Asthma

Mastocyte

Fc-Receptor

Histamine

Mucus Skin

IgE
Asthma in Children & Adolescents

- Asthma is the most often diagnosed chronic disease in childhood and adolescence
  - Statistically 2 – 3 children in one class are suffering from asthma
  - In 70 – 90% of all children asthma occurs as a reaction to physical strain
Precautions for P.E. Classes with Asthmatic Pupils

- A diagnosis of asthma doesn’t mean that the child can’t participate in p.e. classes
- Precautions:
  - Briefing of the p.e. teacher, especially regarding the intensity of asthma
  - Optimal baseline drug therapy
  - Keep spray always within reach for acute treatment
One Training Session a Week increases Physical Performance of Adult Asthma Patients

21 asthmatic patients (~56 J.)

- Spiro-ergometry

Training (n=13) 1 year

Control (n=8)

Spiro-ergometry

A. Meyer et al., Pneumology 51(1997) 845-849

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A. Meyer et al., Pneumology 51(1997) 845-849
Exercise Recommendations for Asthma Patients

- Warm up
  - progressive and very long warm up including short breaks [>10min.]

- Intermittent exercise is preferable
  - avoid hyperventilation

- Breathing against resistance widens the bronchi, e.g. swimming

The drug therapy has to be so good that any sport is possible!!!