Emotional status does not alter exercise tolerance in patients with chronic obstructive pulmonary disease

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Abstract: Exercise tolerance in chronic obstructive pulmonary disease (COPD) patients has been shown to be related to airway limitation and dyspnoea, but little is known about the effects of an emotional status on physical performance.

We examined 49 COPD patients with a wide spectrum of airway limitation severity and hypoxaemia. Exercise tolerance was evaluated using the Six-minute Walking Distance Test (6MWD), dyspnoea at rest and on exercise was measured using the visual analogue scale, and the emotional status was evaluated using the battery of psychological tests.

The average 6MWD (mean±SD) was 355±112 m. In the majority of patients a fall in arterial blood oxygen saturation (SaO2) on exercise of >3% was found. The mean dyspnoea score of 21±19 at rest increased to 66±19 on exercise. All subjects demonstrated an increased level of anxiety. The majority also demonstrated elevated emotional tension, and half of the study group showed signs of depression. Step-wise multiple regression analysis with results of 6MWD as dependent and other studied variables as independent variables showed that exercise tolerance depended mainly on airway limitation. The forced expiratory volume in one second (FEV1) explained 24% of the variance. The forced vital capacity added a further 10%, and arterial blood carbon dioxide tension contributed 7%. The dyspnoea level on exercise added only 0.9%. All four variables explained 42% of the variance. There was no correlation between 6MWD and any of the variables characterizing the emotional status.

We conclude that the emotional status of chronic obstructive pulmonary disease patients is characterized by an increased level of psychological tension, anxiety and depression, but these do not affect exercise tolerance as assessed by the six-minute walking distance test.

Keywords: COPD, dyspnoea, exercise tolerance, lung function, psychological status

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Patients and methods

Forty-nine COPD patients, 38 males and 11 females, were investigated. The mean age (±SD) was 58±8 yrs, ranging from 37–73 yrs. The diagnosis was based on history, clinical examination, lung function tests and chest radiography [11]. To avoid the inclusion of patients with asthma, subjects with a >10% improvement in forced expiratory volume in one second (FEV1), and/or forced vital capacity (FVC) after inhalation of β-agonists, and blood or sputum eosinophilia, were excluded. All subjects were in a stable state, with no signs of respiratory infection or heart failure or any concomitant disease that could influence their exercise tolerance or their psychological status. They were treated with inhaled bronchodilators - ipratropium bromide, β2-agonists and oral theophylline. Six patients were on domiciliary long-term oxygen therapy.

We used three psychological tests, all in the form of questionnaires. J. Taylor's MAS test [12] is a questionnaire with 100 items assessing anxiety, The results were converted into a standardized ten-point scale. The score 1–3 was assessed as a low level of anxiety, score 4–6 as moderate, and score 7–10 as a high level of anxiety. Beck's Depression Inventory [13] is a questionnaire of 21 items assessing depression. The results of Beck's Inventory were classified as follows: 0–9 Points - no depression, 10–14 points - borderline depression, >14 points - depression. The SOPER scale [14] is a 109 items questionnaire divided into five sections: general mood, psychological tension, self-esteem, attitude towards therapy, and attitude towards
future and life goals. The results in each section are converted into a standardized ten-point scale. In all sections, a higher score signifies a better psychological status, except with psychological tension where the scoring is opposite. This scale is a Polish modification of the Cattell Scale [15]. All methods used have updated standardization giving normal values for a Polish population. One of the authors (J.B.), psychologist, instructed the patients on how to complete the tests. The questionnaires for all psychological tests were filled in by the patients on the day preceding the exercise test. The psychologist was at hand to help in case of difficulties in completing tests.

Spirometry was performed using Vitalograph Alpha dry spirometer (Vitalograph, Buckingham, UK). Normal values were those of European Community for Coal and Steel (ECCS) [16]. Arterial blood gases were measured using microelectrode method (Corning-248, Corning-Ciba, Halstead, UK). The exercise tolerance was evaluated at Six-minute Walking Distance Test (6MWD) [17]. The test was performed on normal medication, breathing normal air at least 2 h after breakfast. To avoid the well-known learning effect [18], subjects were submitted to two preparatory walks during two preceding days. The patient was allowed to adjust his/her pace during the test, and to stop for rest if necessary. The test supervisor carried a pulse oximeter and encouraged the patient to greater effort. Arterial blood oxygen saturation (SaO2) during the 6MWD was monitored continuously using a pulse oximetry (Biox 3700, Ohmeda, Boulder, CO).

Dyspnoea at rest immediately prior to exercise (D1) and maximal dyspnoea during exercise (D2) were evaluated using the visual analogue scale (VAS) 1–100 [19].

Statistical analysis

The arithmetical means and standard deviations of all studied variables were calculated. The results of the exercise test were related to independent variables, i.e. lung function data, dyspnoea score at rest and during exercise and psychological variables using multivariate statistical analysis. Pearson's rank correlation coefficients were calculated for the independent variables.

Results

The degree of the lung function impairment varied between patients, but most of them had severe airway limitation. FEV1 was <1.0 L in 30 patients (62%). Hypoxaemia (arterial oxygen tension (PaO2) <9.3 kPa) was observed in 40 subjects (80%). Hypercapnia (arterial carbon dioxide tension (PaCO2) >6.0 kPa) was found in 19 patients (30%). The results of the lung function tests of the studied group are shown in Table 1.

During the 6MWD the patients walked 120–530 m with a mean±SD of 355±122 m. In all, but one patient a fall in SaO2 during exercise was recorded. In 34 patients, the fall in SaO2 exceeded 3% of the baseline level.

Dyspnoea at rest ranged 0–76, with an average of 21±19 (Table 1). On exercise, dyspnoea increased on average to 66±19, with individual changes ranging from 20–95. Only in two patients was there no increase in dyspnoea score on exercise.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean±SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>6MWD m</td>
<td>355±122</td>
<td>120–530</td>
</tr>
<tr>
<td>FVC L</td>
<td>2.6±0.7</td>
<td>1.31–4.5</td>
</tr>
<tr>
<td>FVC % pred</td>
<td>60±16</td>
<td>33–97</td>
</tr>
<tr>
<td>FEV1 L</td>
<td>1.6±0.5</td>
<td>0.4–2.3</td>
</tr>
<tr>
<td>FEV1 % pred</td>
<td>32±14</td>
<td>13–68</td>
</tr>
<tr>
<td>PaO2 kPa</td>
<td>7.8±1.3</td>
<td>5.6–10.2</td>
</tr>
<tr>
<td>PaCO2 mmHg</td>
<td>59±9.7</td>
<td>42–77</td>
</tr>
<tr>
<td>PaCO2 kPa</td>
<td>5.7±1.0</td>
<td>4.7–8.6</td>
</tr>
<tr>
<td>SaO2 rest %</td>
<td>93±3.5</td>
<td>83–98</td>
</tr>
<tr>
<td>SaO2 exercise %</td>
<td>85±9.5</td>
<td>60–97</td>
</tr>
<tr>
<td>D1</td>
<td>21±19</td>
<td>0–76</td>
</tr>
<tr>
<td>D2</td>
<td>66±19</td>
<td>20–95</td>
</tr>
<tr>
<td>∆D</td>
<td>44±24</td>
<td>0–91</td>
</tr>
</tbody>
</table>

Means, m and range of studied variables are shown. 6MWD: distance covered during six-minute walking test; FVC: forced vital capacity; FEV1: forced expiratory volume in one second; PaO2: arterial blood oxygen tension; PaCO2: arterial blood carbon dioxide tension; SaO2: arterial blood oxygen saturation; D1: dyspnoea at rest; D2: dyspnoea during exercise; Drest: dyspnoea at rest; Dexercise: dyspnoea on exercise; ∆D: difference between resting and exercise dyspnoea.

None of the patients was in a good or stable psychological status. All subjects demonstrated an increased level of anxiety. A high level of anxiety (≥27 points) was present in 24 patients and 25 patients had a moderate level of anxiety. Twenty-three patients had a normal Beck's depression score (≤9 points). In 17 patients, the score was slightly or moderately elevated (10–14 points). Nine patients showed a markedly elevated score (15–35 points).

Nine patients demonstrated a very high level of psychological tension, >7 points in the ten-point scale. Thirty-seven subjects had a moderate level of psychological tension (4–6 points). Only three patients did not feel any psychological tension (<3 points). Twenty-three patients had a positive attitude towards therapy (≥7 points). Twenty-one patients had an average attitude (4–6 points), and five subjects had a low attitude towards therapy (<3 points). None of the patients had a positive attitude towards future and life goals. Thirteen patients had an average attitude (4–6 points) and 36 patients had a negative attitude (<4 points). Twenty-eight patients had high self-esteem (≥7 points) and the rest of the group had an average self-esteem (4–6 points).

Correlations between 6MWD, lung function, and psychological status are shown in Table 2. The results of the 6MWD correlated strongly with FEV1 (r=0.62) and FVC (r=0.58) and weakly with PaCO2 (r=0.31) and D2 (r=0.31). The distance walked during 6 min did not correlate with other lung function variables such as PaO2, SaO2 at rest and on exercise, dyspnoea at rest and an increase in dyspnoea on exercise (AD). There was no correlation between 6MWD and any of the variables characterizing emotional status, depression (r=0.27), anxiety (r=0.23) or emotional tension (r=0.23).

Correlations between PaO2 and SaO2, at rest and dyspnoea on exercise were weak r=0.37 and -0.32 respectively. PaO2 correlated with general mood (r=0.31) and depression (r=0.37). FVC correlated negatively with anxiety (r=0.32).
and self-esteem (r=0.34). Attitude towards the future and life goals correlated with FEV₁ (r=0.29), D₂ (r=0.29) and ∆D (r=-0.39).

Multivariate step-wise regression analysis for 6MWD showed that FEV₁ explained 24% (p=0.003) of the variance, FVC contributed 10% (p=0.033), PaCO₂ added a further 7% (p=0.08), ∆D added only 0.9%. All four variables explained 42% of the variance. The psychological variables did not add to the analysis of the variance.

**Table 2.** – Correlations (r) between psychological variables and results of the pulmonary function tests, dyspnoea and six minute walking test (6MWD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>General mood</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Psychological tension</th>
<th>Self-esteem</th>
<th>Future and life goals</th>
<th>6MWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO₂</td>
<td>0.31*</td>
<td>-0.37**</td>
<td>-0.07</td>
<td>-0.12</td>
<td>0.26</td>
<td>-0.10</td>
<td>0.27</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>-0.03</td>
<td>0.18</td>
<td>0.23</td>
<td>0.09</td>
<td>-0.07</td>
<td>-0.18</td>
<td>-0.31*</td>
</tr>
<tr>
<td>FVC</td>
<td>-0.26</td>
<td>-0.26</td>
<td>-0.11</td>
<td>-0.45</td>
<td>0.34**</td>
<td>0.25</td>
<td>0.58***</td>
</tr>
<tr>
<td>FEV₁</td>
<td>-0.21</td>
<td>-0.24</td>
<td>-0.14</td>
<td>-0.12</td>
<td>0.29*</td>
<td>0.25</td>
<td>0.62***</td>
</tr>
<tr>
<td>SvO₂ (rest)</td>
<td>-0.01</td>
<td>-0.17</td>
<td>-0.04</td>
<td>-0.05</td>
<td>-0.07</td>
<td>0.12</td>
<td>0.07</td>
</tr>
<tr>
<td>SvO₂ (exercise)</td>
<td>-0.00</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.05</td>
<td>-0.07</td>
<td>0.12</td>
<td>0.07</td>
</tr>
<tr>
<td>Drest</td>
<td>0.00</td>
<td>-0.20</td>
<td>-0.12</td>
<td>-0.01</td>
<td>-0.10</td>
<td>0.20</td>
<td>-0.16</td>
</tr>
<tr>
<td>DExercise</td>
<td>-0.02</td>
<td>0.22</td>
<td>0.23</td>
<td>0.25</td>
<td>-0.02</td>
<td>-0.28*</td>
<td>-0.31</td>
</tr>
<tr>
<td>∆D</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.27</td>
<td>0.20</td>
<td>0.06</td>
<td>-0.39**</td>
<td>-0.12</td>
</tr>
<tr>
<td>6MWD</td>
<td>0.18</td>
<td>-0.27</td>
<td>-0.23</td>
<td>-0.23</td>
<td>0.26</td>
<td>0.22</td>
<td></td>
</tr>
</tbody>
</table>

For abbreviations, see table 1. *: p<0.05, **: p<0.01, ***: p<0.001.

**Discussion**

Exercise tolerance in COPD patients is limited by the severity of airway obstruction and dyspnoea [1–4]. It is also well known that COPD patients often present with depressed mood, anxiety and depression related to the severity of airway limitation [20–24]. Our investigation is the first to demonstrate that there are no reciprocal relations. We found that exercise tolerance in COPD is not affected by abnormalities in emotional status.

There are some limitations to this study. One is the reproducibility of the exercise and the psychological tests that we used. Exercise tolerance was assessed with the 6MWD. This test is easy to perform and widely used in clinical practice. However, it was found that there is a learning effect. Results of the test improve up to the third repetition on consecutive days [18]. To avoid such a bias, we performed two preparatory tests to familiarize the subjects with the procedure.

Contrary to the exercise test, the psychological tests used were constructed to be applied only once. They ask questions that are easy to answer. There is no change in the pattern of answers during consecutive repetitions. They are assessing the attributes of mood that remain stable with no day-to-day variability.

We studied a typical group of COPD patients. Their exercise tolerance correlated with the severity of airway limitation and dyspnoea. The majority of our patients showed signs of anxiety, depression, stress, pessimism and somatic preoccupation. There are several mechanisms that may be responsible for psychological distress in COPD patients. The limitation of physical performance leads to a loss of social and family position, especially in males [22]. Loneliness and reduced social support [25], difficulties in sexual activity [26], dissatisfaction with life, and poor self-image [27] also contribute. Dyspnoea, a common, very unpleasant sensation, is one of the strongest stress factors.

Most studies of psychological factors in patients with COPD indicate that depression, anxiety, and increased psychological tension are common [8–10, 28, 29] and correlate with severity of respiratory impairment [9, 21].

Our finding that this is a one-way relation is supported by outcomes of rehabilitation programmes. The results of the programmes based solely on psychological interventions were negative, indicating that stress management alone had minimal impact on overall functional status [30] or anxiety [31, 32].

Physical exercise training, however, resulted not only in the improvement of exercise tolerance but also in a reduction of psychological distress. Gatziu et al. [33] found reduced anxiety after a 28 week outpatient exercise programme significantly improving exercise tolerance. Dekker et al. [34] found significant reductions in depression and anxiety after 10 week outpatient rehabilitation programme. Similar findings were reported by Emery et al. [35].

Interestingly, we found a significant correlation (r=0.39, p<0.006) between the attitude towards the future and life goals and an increase in breathlessness during exercise (∆D). Patients who presented with severe dyspnoea on exercise had a passive attitude towards their future and had no clear-cut life goals. They also had no motivation to overcome the difficulties of everyday life. They were missing an elementary life boost.

On the contrary, patients who had the best score in tests assessing attitude towards future and life goals had little increase in dyspnoea during exercise. A determined time line and a vision of an attractive future are prerequisites of success. The ability to create plans for the future increases the threshold of pain, suffering, or dyspnoea [36, 37]. Recently, Karlan et al. [38] found that the patient’s belief that he/she will be able to complete a walking test was a good prediction for survival over a five-year period.

In conclusion, although severe psychiatric forms of anxiety and/or depression may affect physical activity even in a somatically normal person, it appears that moderate levels of mood disorders do not influence exercise tolerance in patients with chronic obstructive pulmonary disease.

**References**

1. Matthews JI, Bush BA, Ewald FW. Exercise responses during incremental and high intensity and low intensity


