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Analysis of nutritional status disturbances in patients with chronic obstructive pulmonary disease

Abstract

Introduction: Among the most common extrapulmonary manifestations of COPD are nutritional status disorders. The specific loss of weight, called cachexia, characterized by loss of lean body mass in some COPD patients is observed. The aim of the study was the quantitative and qualitative analysis of COPD patients' nutritional status disturbances.

Material and methods: Fifty-five patients in different stages of COPD — 43 males and 12 females (mean age 62.31 ± 11.08) and 32 subjects from a control group (mean age 57.43 ± 8.79) participated in the study. In both groups nutritional status was assessed using different indicators such as PIBW — percentage of ideal body weight, BMI — body mass index, FFMI — fat-free mass index and FMI — fat mass index.

Results: Malnutrition measured by PIBW, BMI, BMI percentiles, and FFMI was observed in 5.45%, 3.64%, 3.64% and 18.18% of COPD patients, respectively, and in the control group 3.12%, 0%, 3.12% and 3.12%, respectively. The BMI mean value did not differ significantly between groups. It was confirmed that cachexia assessed by FFMI occured more frequently in COPD patients than in the control group — 19.05 kg/m^2 vs. 20,55 kg/m^2 ($p = 0.04$).

Conclusions: 1. Nutritional status disorders pose a serious problem, which concerns about 1/5 of the COPD population. 2. It is necessary to perform quantitative analysis of nutritional status (assessment of lean and fat mass) because indicators of body mass (PIBW, BMI) are not sufficient for cachexia detection. 3. Having normal body mass does not exclude the possibility of nutritional status disorders in COPD patients.

Key words: nutritional status, COPD, cachexia

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Introduction

During the course of COPD the inflammatory process appears, which takes place within respiratory system as well as in distant systems and organs. Among the most common extrathoracic manifestations of the disease are nutritional status disturbances and skeletal muscle mass weakness.

In some COPD patients, specific loss of weight and worsening of nutritional status take place [1, 2]. Different frequencies of this phenomenon have been reported (between 20 to 40 percent) depending on choice of study group [3, 4]. Loss of body mass in COPD is a loss of fat-free mass (FFM), which consists mainly of muscles, with a relative increasing or no change in fat mass (FM) [5].

Similar disorders of nutritional status can be observed in other chronic inflammatory diseases such as rheumatic arthritis, heart failure and chronic renal insufficiency, as well as in cystic fibrosis patients [6–9]. In the literature these disorders are assessed as a cachexia and are connected with an increased level of anti-inflammatory cytokines [10, 11]. Nutritional status disorders can lead to negative clinical consequences. Loss of body mass is a cause of disturbances in breathing physiology. In patients with low body mass the diffusion capacity is diminished, "air trapping" is increased as a consequence of dyspnea [12]. On the other hand, lower mass of breathing muscles, especially the diaphragm, can implicate decreased strength and period of constriction and, as a consequence, loss

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Table 1. Characteristics of study and control group

	Number of people	Gender (M/F)	Mean age (years)	Body mass (mean value in kg)	Height (mean value in cm)	Current/ex-smokers
SG	55	43/12 78%/22%	62.31± 11.08	77.24 ± 16.15	168.76 ± 8.14	21/34 38%/62%
CG	32	25/7 78%/22%	57.43 ± 8.79	83.11 ± 15.58	172.40 ± 8.38	12/20 37.5%/62.5%
p			p = 0.06 (NS)	p = 0.04	p = 0.06 (NS)	

SG — *study group*; CG — *control group*

of effectiveness. Something similar happens with skeletal muscles [13]. Consequently, nutritional status or loss of body mass is a factor that can have an unfavourable influence on quality of live and is a negative prognostic factor. There is also an independent risk factor of death caused by breathing problems [14–16].

Many trials of feeding were taken up in COPD patients to find nutritional status disorders, but the majority of these trials were ineffective [17].

The aim of the study was to analyse nutritional status disorders in COPD patients. This aim was realised by:

— assessment of frequency of cachexia;
— quantitative and qualitative analysis of COPD patients' nutritional status disturbances.

Materials and methods

Characteristics of study population

Study group

The study group consisted of 55 COPD patients (diagnosis according to GOLD criteria — FEV1%FVC < 70) in different COPD stages (I° — 29.09%, II° — 29.09%, III° — 36.37%, IV° — 5.45%). The patients were qualified from outpatient clinics where they made scheduled visits, as well as from clinical patients where who were admitted, in a stable state of the disease, into control tests or qualification for home oxygen therapy.

All of them were current or past smokers (all past smokers quit smoking more than 5 years before the beginning of the research), in a stable state of the disease, i.e. there was no exacerbation during 6 weeks before the trial. Four patients from the group of examined patients were treated with oxygen at home.

Control group

The control group consisted of 32 healthy volunteers who entered spontaneously during screening tests for COPD diagnosis in order to do spirometric tests.

They were current or past smokers who did not suffer from pulmonary diseases, either now or in the past. Neither lung disease symptoms nor physical examination deviations were stated in their cases. The results of spirometry were normal. The control group was matched to the examined group according to age, sex, height and smoking addiction.

Table 1 presents the characteristics of the study group (SG) and control group (CG).

All patients with active or past diseases that could affect nutritional status disorders (diseases of the heart, kidney, liver, diabetes, colagenosis, neoplasmatic processes), as well as people using oral glucocorticoids, diuretics or antihistaminic drugs, were excluded from the study.

Each of the patients was informed about the rules and aims of the study and qualified after conscious consent. The protocol of the study was approved by the Local Bioethical Committee of the Medical University in Poznań.

Assessment of nutritional status

The following tests were made in both groups for assessment of nutritional status:

1. Body mass and height examination

Body height and weight were measured in all subjects from the study and control groups with a beam scale to the nearest 1 cm and 0.1 kg.

The following parameters of body mass were analysed:

— **PIBW** (percentage of ideal body weight) — this parameter determined the percentage of ideal body mass. **IBW** (ideal body weight) was calculated using Broc's formula: IBW = [(height in centimeters–100) – 10%] for females; [(height in centimeters–100) – 5%] for males in all examined subjects. Real body mass, measured by beam scale was showed in percentage of ideal body mass (PIBW). PIBW < 90% was treated as malnutrition.

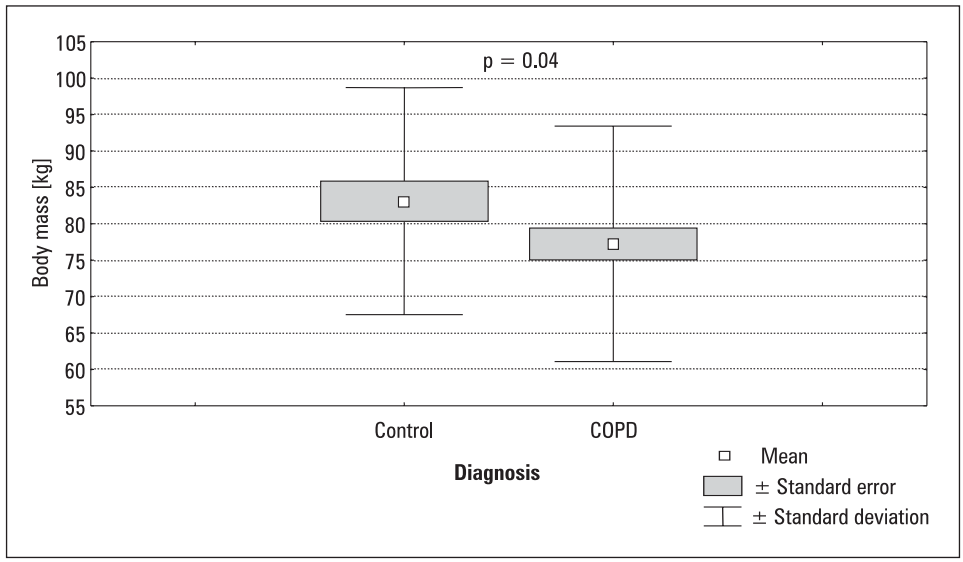

Figure 1. Comparison of mean values of body mass in study (COPD) and control group

— **BMI** (body mass index) — indicator of body mass, defined as [body mass (in kilograms)]/ /[height (in meters)^2], was calculated in each subject from the study and control groups based on measure of body mass and height. BMI is a quantitative parameter for the assessment of nutritional status. Normal BMI is assessed by values in the range between 20 and 25 kg/m^2. BMI less than 20 kg/m^2 indicates undernutrition, more than 25 kg/m^2 overnutrition, and results higher than 30 kg/m^2 show obesity [18]. According to other sources, undernutrition is assessed by BMI < 18.5 kg/m^2 [19]. In the current study, in order to separate the study group with malnutrition, both border values were used and compared. The percentage index of BMI was also used; extremal values, that were proof of malnutrition or undernutrition, were taken as the 5th and 95th percentiles of BMI [20].

2. Examination of body composition

Body composition was measured by a piece of equipment known as a body composition analyser (Bodystat 1500). The principle of its operation is based on bioelectrical resistance.

Subjects were examined in the supine position. Four measuring electrodes were placed in distal parts of the extremities in the wrist and instep area. The following parameters of body composition were analysed:

— **FM** (fat mass — relative fat mass measured in percentage of proper value, and absolute value measured in kilograms).

— **FFM** (fat free mass — relative fat free mass measured in percentage of proper value, and absolute value measured in kilograms). **FFMI** was calculated based on the measurement of FFM; FFMI = [FFM (kg) / height (m)]^2. Values lower than or equal to 15 kg/m^2 for females and 16 kg/m^2 for males indicate a depletion of fat free mass [21]. In the further part of the study, regarding fat free mass, FFMI (fat free mass index) was used.

Statistical analysis

Statistica 5.1 PL software (StatSoft Inc.) for Windows was used for statistical analysis. The normality of data distribution was first checked by Shapiro-Wilks' W test. Differences between subsequent groups were compared by Mann-Whitney test (for independent samples). The results of the statistical analysis were considered significant when $p < 0.05$.

Results

Nutritional status

Parameters of body mass

PIBW

Average body mass in the COPD group was 77.24 ± 16.15 kg, and it was significantly lower than in the control group 83.11 ± 15.58 kg ($p = 0.04$). This comparison is shown in Figure 1.

BMI

BMI was located in a wide range from 18 kg/m^2 to 42 kg/m^2 in the control group. Only in 2 people among the COPD patients was BMI < 20 kg/m^2 confirmed. Normal BMI was found in 14 patients (25.45%). In the remaining 39 (70.91%) subjects with COPD, calculated BMI was above 25 kg/m^2:

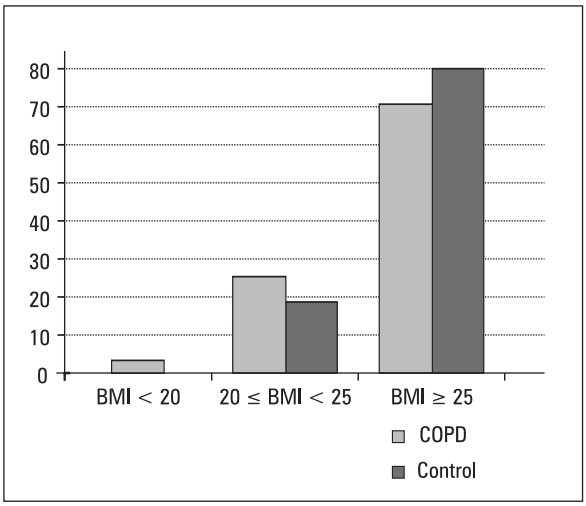

Figure 2. Comparison of body mass indicators (BMI) in study (COPD) and control group

27 subjects (49.09%) were overweight, and 12 of them (21.82%) were obese.

In the control group, the range of BMI was from 20 kg/m^2 to 39 kg/m^2. In all examined subjects from the control group, BMI was in the normal range or indicated overnutrition. Normal BMI was found in 6 subjects (18.75%), increased body mass index was observed in 26 (81.25%), 16 (50%) indicated being overweight and 10 (31.25%) indicated obesity.

A comparison of the different ranges of BMI in the groups is shown in Figure 2.

For comparison, BMI was assessed using a percentile ratio. BMI below the 5th percentile was found in 2 subjects (3.64%) from the study group. There were 52 (94.54%) subjects from the study group in the range between the 5th and 95th percentiles, which was the majority. BMI below the 5th percentile was found in 1 subject (3.12%). There were 29 (90.62%) subjects in the range between the 5th and 95th percentiles.

The calculated average BMIs in the study and control groups were 27.24 ± 4.83 kg/m^2 and 28.00 ± 4.12 kg/m^2, respectively. There was no significant difference of BMI between the study and control groups ($p = 0.35$). A comparison of the average BMI values in both groups is shown in Figure 3.

Components of body mass

FFMI

A decrease of fat free mass assessed as FFMI was found in 10 (18.18%) subjects from the study group. Decreased FFMI was observed in 2 women and 8 men (3.63% and 14.55%, respectively). The frequency of fat free mass deficiency did not differ significantly in both genders, being 16.66% in females and 18.60% in males. In the control group, FFMI below 15 kg/m^2 was found in 1 woman (3.12%).

Average FFMIs in the study and control groups were 19.05 ± 3.44 and 20.55 ± 3.19 kg/m^2, respectively. Comparison analysis was made in both groups. A significant difference of fat free mass between the groups was found — in the study group, fat free mass was significantly lower than in the control group. The results of this analysis are shown in Figure 4.

FM

The average fat free mass index in both groups was calculated and compared. Mean fat free mass index was 7.93 ± 3.19 kg/m^2 in the study group and 7.97 ± 3.95 kg/m^2 in the control group. There were no differences of fat mass in comparison analysis between the examined groups.

Nutritional status and progression of the disease

An analysis of the connection between nutritional status (measured by BMI and FFMI) and the stage of the disease (measured by FEV1) was made in both groups.

A weak positive correlation was observed between FFMI and FEV1 in COPD patients (R Spearman = 0.30; $p = 0.03$). Loss of fat free mass was associated with a decrease of FEV1 (more advanced disease). BMI did not correlate with FEV1 (R Spearman = 0.17; $p = 0.27$).

Discussion

The inflammatory process in the development of COPD induces damage of many organs. Among the most common negative consequences of the disease are nutritional status disorders, which are characterized by loss of fat-free mass.

When these consequences are considered, as well as the slight therapeutic possibilities, interest in this subject seems to be fully justified. There have not been any standards published up to now. In the current study, method selection was one of the most common basic problems. It was difficult to find the correct parameters which would be most characteristic for the assessment of nutritional status in COPD patients.

There are some different indicators of malnutrition and ranges between COPD patients in some trials, which have been presented so far. The assessment of different parameters in the following studies give no chance to draw a consequent comparison between them.

Several indicators were used for the assessment of body mass in the current study to observe possible differences caused by choice of method. Mal-

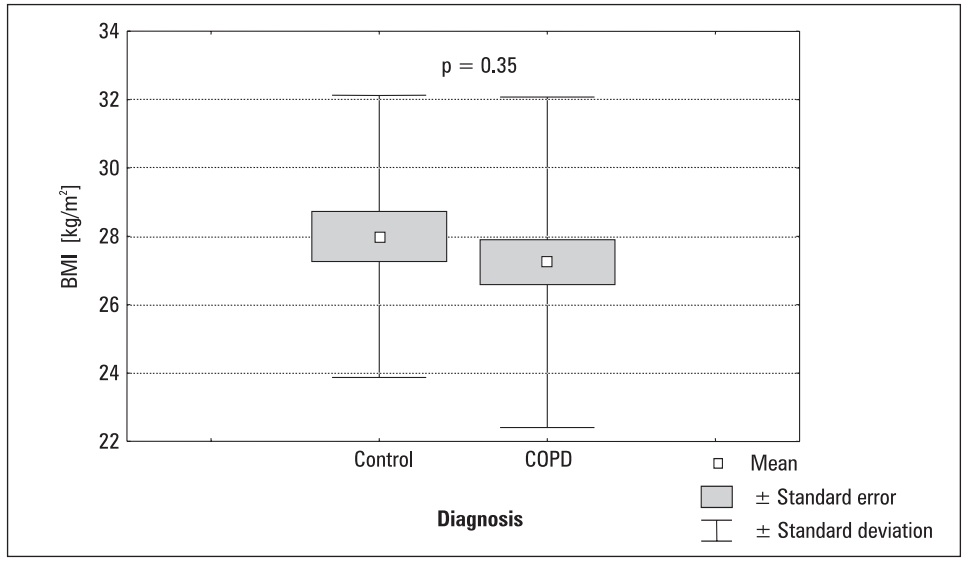

Figure 3. Comparison of mean BMI indicators in study (COPD) and control group

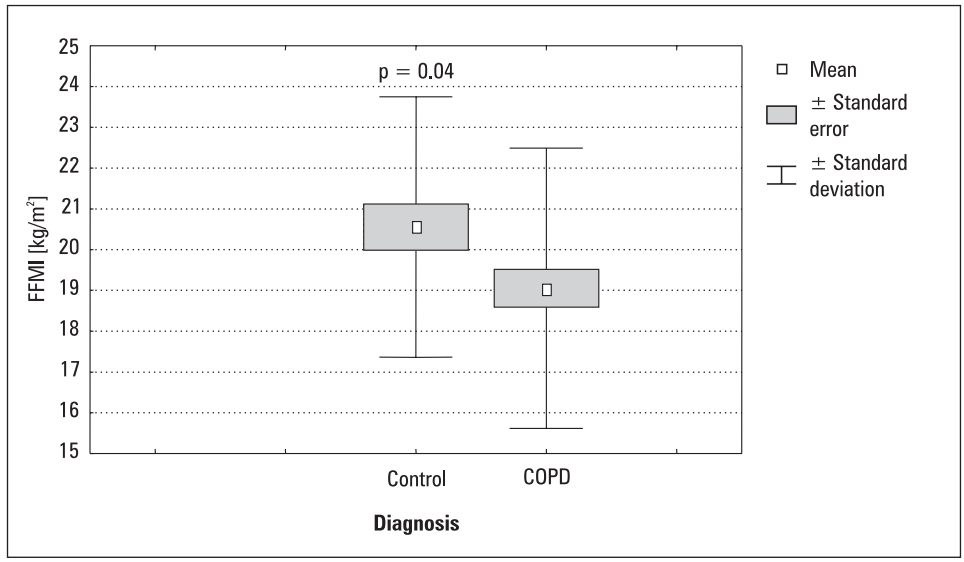

Figure 4. Comparison analysis of FFMI in study (COPD) and control group

nutrition was determined as a value less than 90% of ideal body mass. Ideal body mass was calculated from Brock's formula. Such determined malnutrition was found in 3 COPD patients (5.45%). This percentage was lower in comparison with any other author's studies, in which malnutrition assessed as < 90% IBW was found in 24% [4] and 35% [1].

No significant differences of nutritional status were observed — assessed by BMI — between the study and control groups. Malnutrition, determined as BMI < 20 kg/m^2, was confirmed in 2 (3.64%) COPD patients. In other trials, malnutrition estimated in this way occurred in 3.9% [20], 6.6% [22] and 23% [23] of patients. In several studies, the normal value of BMI was determined in the range between 18.5 kg/m^2 and 25 kg/m^2, and consequently the percentage of malnutrition decreased [24]. When we assessed the range of BMI norm in this way, in the current study all COPD patients had normal body weight.When we used a borderline value of BMI under the 5th percentile, more patients with malnutrition, in comparison with borderline value BMI < 20 kg/m^2, were found. This phenomenon was observed by Soler and colleagues, who calcualated malnutrition in 19.1% of patients using BMI under the 5th percentile and 3.9% for BMI < 20 kg/m^2 [20]. In the current study, malnutrition (determined as BMI under the 5th percentile) was certified in 2 patients. It is the same value when using BMI range of norm.

Normal body mass and body mass index are parameters that do not assess the kind of nutritional status, especially body composition, in COPD patients. In a study by Spanish researchers (Soller and colleagues), in 62.9% of patients without loss of complete body mass (20.7% of them with overnutrition and obesity), nutritional status disorders were confirmed [20]. In the study by Schols et al, in 14.8% of patients with normal body mass, fat-free mass loss was confirmed [1]. These differences can result from a lack of homogenous definition of complete body mass deficiency, as well as loss of fat free mass.

In the proper study, the division of body mass into components showed well-defined differences of nutritional status between the groups. Significant differences in fat-free mass were observed, as well as fat mass between the COPD and control groups. The COPD patients more frequently lost muscle mass, whereas for those from the control group, a greater percentage of muscle mass was characteristic. These analyses confirmed the selective loss of body mass in the course of COPD.

In 18.81% of COPD patients, decreased FFMI was stated. In other studies, a different percentage of patients was observed, who had, defined in this way, quantitative disorders of nutritional status: from 20% for out-patients [22], through 35% for hospitalised patients [1], to 45% for those waiting for lung transplantation [4]. This diversity of results was the consequence of different stages of the disease in different examined groups.

It should be emphasised that the nutritional status of COPD patients was compared with a control group (as was done in the current analysis) only in a few studies.

To summarize, in the current study, a relatively low percentage of people with nutritional status disorders was stated, defined by various parameters, in different stages (I–IV° according GOLD) in the group of COPD patients. This is not a rare problem, because according our own data it concerns on average every fifth COPD patient. The higher percentages of malnourished COPD patients in other studies are the consequence of qualification of more selected groups of patients in more advanced stages of the disease.

Presently in clinical practice, despite knowledge about possible malnutrition in COPD patients, no routine assessment of nutritional status is carried out. It should be considered that such assessment could have a place in control examinations in patients with diagnosis of COPD. According to previous and our own studies, body mass, fat mass and fat-free mass are the most common parameters, and seem to be the most significant as well. Observation of these parameters can be especially useful for long-term control of nutritional status.

Conclusions

1. Nutritional status disorders are an important problem concerning about 1/5 of the COPD population.
2. It is necessary to perform quantitative analysis of nutritional status (assessment of lean and fat mass) in COPD patients because indicators of body mass (PIBW, BMI) are not sufficient for cachexia detection.
3. Evaluation of normal body mass does not exclude nutritional status disorders in COPD patients.

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