INTERRELATIONS OF BODY COMPOSITION AND QUALITY OF LIFE IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Abstract

Background: Interrelations of body composition and quality of life in chronic obstructive pulmonary disease (COPD) are important, since low body mass index (BMI) and muscle atrophy are basic factors of low exercise capacity and have reliable predictive value of the progressing disease. The aim of our study was to assess how body composition affects the quality of life, exercise capacity and respiratory function of COPD patients

Methods: We performed body composition measurements on 120 COPD patients of the National Koranyi Institute for Pulmonology in Budapest between February 1, 2019 and February 1, 2020, using OMRON Healthcare BF511 body composition analyser. The disease-specific COPD Assessment Test (CAT) questionnaire measured the quality of life; respiratory function and anthropometric data were extracted from the electronic health record system.

Results: Underweight patients (10.8%) were less work loading (6MWD (m) 250 vs. 320; p=0.098) and had significantly lower quality of life (CAT: 32 (29-36) vs. 28 (23.5-30) vs. 24 (16-30); p=0.004), than normal or overweight patients. Those with higher body fat percentage (women: 36-42%, men: 25-30%) had better lung function (FEV1) and significantly better quality of life (CAT). Muscle percentage correlated also significantly with 6-minute walking distance (6MWD: ρ=0.514; p <0.001) and quality of life (CAT: ρ=-0.344; p <0.001).

Conclusions: Our results suggest that measurement and assessment of body composition is useful in managing COPD patients and should routinely be performed during therapy, thus we propose to add body composition assessment to the COPD severity assessment (BODE index).

Keywords: chronic obstructive pulmonary disease (COPD); body composition; quality of life; COPD Assessment Test (CAT); BODE index

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Introduction

COPD (Chronic Obstructive Pulmonary Disease) is insidious and irreversible that progresses and worsens at different rates depending on specific circumstances [1]. There are many factors affecting the quality of life and life expectancy of COPD patients, such as breathing capacity, frequency of acute exacerbations, timely and effective treatment, good lifestyle habits such as regular exercise, adequate diet quality and quantity, smoking cessation and quality of air [2].

Body composition, dietetics, and adequate quantity and quality of nutrition are also becoming increasingly prominent of COPD patients' quality of life and treatment, since inadequate body composition is leading to a decrease in muscle volume and increases the fat content, with adverse consequences in pathological cases as sarcopenia or sarcopenic obesity, resulting in malaise, frailty and poorer life outcomes [3].

Previous studies highlighted that early detection and initiation of nutritional therapy may improve significantly the respiratory function, exercise tolerance and quality of life, as well as reducing morbidity and mortality of COPD patients [4-6]. Actually, body composition analysis is not routinely performed in COPD management, although it should be, because restricted diet, low physical activity and the production of inflammatory cytokines change metabolism to catabolism with increasing incidence of infections, development of nutritional abnormalities thus reducing the quality of life [7]. The aim of our study was to assess how body composition affects the quality of life of COPD patients.

Materials and methods

Study Design and Population

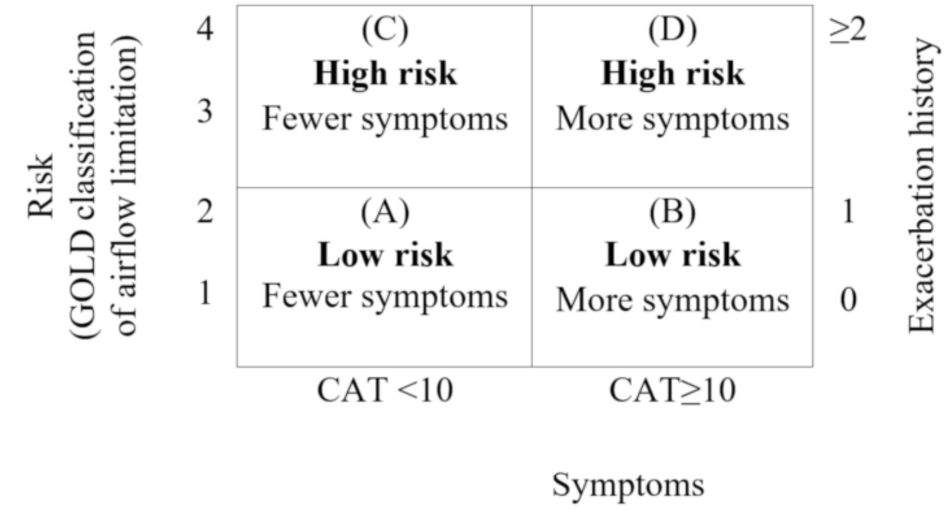
Our cross-sectional study included 120 COPD patients in the National Koranyi Institute of Pulmonology. The study approved the local TUKEB Ethical Committee Licence Number: TUKEB 44402-2 / 2018 / EKU - approval date 28 August 2018 - and complied with the Helsinki Declaration. Inclusion criteria were: age ≥40 years and diagnosed with COPD (post-bronchodilation of FEV1/FVC <70%) [8]. Exclusion criteria: implanted pacemaker, pregnancy, severe dehydration or oedema, further chronic diseases (e.g. cancer, endocrine system) with major impact on outcomes of instrumental measurements of nutritional status.

Patient and public involvement

Inclusion of patients was based on the institution's electronic database. All patients learned oral and written medical information about the study and signed a statement of consent. Participation was voluntary. Patients and the public were not directly involved in the design of the research or the objectives of the study. However, at patient group meetings, the results of the research and the views expressed by the patients were also made public to the working group and the patients themselves.

Examination of respiratory function

All patients underwent a baseline respiratory function test by automated computerized spirometer for assessing respiratory function. Dynamic lung volumes were defined as the amount of air expelled in the first second [(FEV1 (ref%)], vital capacity [(FVC (ref%)], the degree of airway obstruction (FEV1/FVC), inspiratory capacity in litres and percent [(IVC (L), IVC (ref%)], with GLI-defined (Global Lung Function Initiative) normal spirometry (z-score) [8]. Patients were classified in GOLD A-D stages according to the current and future risk parameters, as spirometric values, relevant symptoms and exacerbation rate (Figure 1) [8].



GOLD=Global Initiative for Chronic Obstructive Lung Disease; CAT=COPD Assessment Test; mMRC= The modified Medical Research Council scale;

Figure 1: GOLD severity stages of chronic obstructive pulmonary disease

Quality of life examination

We used the COPD Assessment Test (CAT) as a complex questionnaire to measure the quality of life [9]. Our patients responded eight questions, scoring the symptoms from 0 (healthy condition) to 5 (severe symptoms). Cough, the amount of sputum, hyperinflation, the load-bearing capacity when climbing stairs, and the level of energy were evaluated subjectively, as well as whether the patients dare to leave home, or whether their illness affected their sleeping habits. In addition, the patients also completed our self-developed questionnaire asking about their smoking and dietary habits. Questionnaires were completed under the coordinators' supervision in the Koranyi facility.

Definition of COPD exacerbation

COPD exacerbation was defined as a significant change of the patient's initial symptoms (dyspnea, cough and sputum production), which is an acute event at a level exceeding the daily variability of symptoms, leading to a change in therapy [8].

The 6-minute walk test (6MWT)

During the 6-minute walk test (6MWD), patients were asked to walk down the aisle for 6 minutes and the maximum walking distance was recorded. 6MWT measures the distance the patient can walk quickly on a hard, flat surface in 6 minutes. This distance value is the result of the test [10].

Body weight, body fat percentage, muscle percentage and body mass index.

While measuring body weight, body fat percentage and muscle percentage we used the OMRON Healthcare BF511 Body Composition Analyser and calculated body mass index. Measuring criteria were empty stomach in the morning, emptied urine bladder and defecation, being in underwear, barefoot and without any metal jewellery. BMI was calculated by dividing body weight by body height squared (kg/m2). Based on body mass index (BMI) values, participants were divided into four groups: <18.5 (underweight), 18.5-24.9 (normal weight), 25-29.9 (overweight) and ≥30.0 kg/m2 (obese) [11].

Body fat percentage is also an important indicator of obesity, as the fat expressed as percentage of body weight, and was used to classify participants into lean (female <24%, male <13%), healthy (female 24-35%, male 13-24%), overweight (female 36-42%, male 25-30%), and obese (female ≥42%, male ≥30%) groups (according to recommendations for those over 60 years) [12].

Blood tests

We conducted fasting blood tests in the central laboratory of the National Koranyi Institute of Pulmonology and measured the serum CRP with high sensitivity (hs) immunoassay method and the lipid profile (total cholesterine, triglyceride, LDL and HDL) standard method. Patients were in clinically stable condition, without fever and respiratory infection throughout the measurements.

Statistical analysis

All statistical analyses were conducted with STATA SE-21.0. Since most of the continuous data did not follow the normal distribution - verified by Sapphiro-Wilk test -, we used non-parametric statistical methods. Continuous variables were represented by medians and interquartile ranges, categorical data were presented with case numbers and proportions. Mann-Whitney tests detected the differences of continuous variables between two groups; in case of more than two groups Kruskal-Wallis ANOVA tests were conducted. Frequency differences of categorical variables were examined by Fisher's exact test. Spearman's correlation tests were used to indicate the relationship between continuous variables. All statistical tests were performed at 95% confidence intervals with significance level $p < 0.05$.

Results

All COPD patients (n=120) were subjected to body composition analysis. Patients' characteristics in median and interquartile range: age: 65 (62-72) years; FEV1 (ref%): 42 (31-53); BMI: 25 (20-31) kg/m², men BMI: 24.7 (20-29), women BMI: 26.8 (21-32). Almost all patients (95%) were smokers, with an average number of 40 years of smoking and an average of 20 cigarettes smoked a day. Malnourished patients had poorer lung function FEV1 (ref%): 29 (27-34) than normal weight FEV1 (ref%): 45 (35-52) or overweight FEV1 (ref%): 42 (35-47), obese patients FEV1 (ref%): 45 (30-56). More than half of patients (52%) reported a weight loss in the last 12 months, with an average of 2.9 kg. Anthropometric characteristics of patients grouped by BMI are detailed in Table 1.

Table 1. Characteristics of the COPD patients by BMI categories

BMI categories (kg/m²)	Underweight <18.5 (n=13)	Normal weight 18.5-25 (n=43)	Overweight 25-30 (n=27)	Obese ≥30.0 (n=37)	p-value
Age (years) (IQR)	61 (57-64)	65.5 (61.26-72)	66 (70-64)	69 (62-73)	0.089
Men (n, %)	8 (61.54)	22 (51.16)	16 (59.26)	14 (37.83)	0.287
Women (n.%)	5 (38.46)	21 (48.84)	11 (40.74)	23(62.16)	0.298
Muscle (%)	44 (33.4-49)	35 (27.7-39.4)	29.4 (27-32.5)	29.2 (25-32.7)	<0.001
Men (%)	46.5 (33-49)	35.4 (28.9-40)	30.7 (26.7-34.4)	32.7 (29.4-33.9)	0.004
Women (%)	40 (33.4-48)	33.3 (27.9-39)	29 (27.7-32)	25.4 (24-29.9)	<0.001
Body fat (%)	11.2 (9-15.9)	25.9 (17.8-34.4)	36 (30.8-41.3)	40 (35-46)	<0.001
Men (%)	10.1 (9-16.1)	18.6 (14.1-32.03)	33.7 (26-38.7)	34.9 (32.2-38.2)	<0.001
Women (%)	15.9 (8-15.9)	29.6 (21-36)	40 (36-42.2)	45.5 (40.7-48.8)	<0.001
AC (cm)	79 (77-81)	92.5 (85-100.5)	105 (90.5-109.75)	114 (102.2-	<0.001
Arm circumference (cm)	23.5 (23-24.5)	26.5 (25-29)	28.75 (24.5-33.9)	32 (29.25-34.12)	<0.001
Total cholesterol (mmol/l)	3.8 (3.8-4.8)	5 (4.32-6.08)	5 (4.25 (5.98)	5.1 (4.45-5.78)	0.064
Triglycerid (mmol/l)	0.8 (0.7-1.4)	1.3 (1-2)	1.5 (1.3-1.7)	1.4 (1-1.9)	0.314
FEV_1 (ref%)	29 (27-34)	45 (35-52)	42 (35.5-47.5)	45 (30.7-56.3)	0.486
FVC (%)	55 (48-62.7)	68 (58.5-81.5)	65.5 (59.25-78)	64.5 (55-76)	0.203
FEV_1/FVC (%)	44 (44-45.7)	49 (42.5-61)	50.5 (41.5-54)	54 (45.5-64.25)	0.392
GOLD stage					
GOLD A (n.%)	1 (7.69)	2 (4.65)	3 (11.11)	1 (2.70)	0.003
GOLD B (n.%)	1 (7.69)	11 (25.58)	3 (11.11)	14 (37.83)	<0.001
GOLD C (n.%)	3 (23.08)	25 (58.15)	17 (62.97)	13 (35.14)	<0.001
GOLD D (n.%)	7 (53.84)	5 (11.62)	4 (14.81)	8 (21.62)	<0.001
CAT (points)	32 (29-36)	28 (23.5-30)	26 (17-29)	24 (16-30)	0.004
6MWD (m)	250 (180-322)	320 (200-410)	320 (252-366)	307 (230-362)	0.098
Exacerbations (in, last 6 months)	1 (0.5-3)	0.5 (0-1)	0.5 (0-1)	1 (0-2)	0.020

Data are presented as median (IQR) or as frequency and percentage; AC: abdomen circumference; GOLD: Global Initiative for Chronic Obstructive Lung Disease; CAT: COPD Assessment Test; FEV1: forced expiratory volume in 1 s post-bronchodilator; FVC: forced vital capacity; BMI: body mass index; 6MWD: six-minute walking distance; HDL: high density cholesterol level; LDL: low-density cholesterol level; $p < 0.05$ means the two indicators were significantly correlated

Malnourished patients had a lower workload (6MWD (m) 250 vs. 320; p=0.098) and significantly poorer quality of life (CAT: 32 (29-36) vs. 28 (23.5-30) vs. 24 (16-30); p=0.004) than normal or overweight patients (see at Table 1). The median body fat percentage for men was 28.1 (17.9-35.9) and for women 36.8 (27.1-43.7). 21.7% of female patients had low body fat percentage, 15% had normal, and 63.3% high percentage. The same values of men were 18.4%, 23.3% and 58.3% respectively. The average muscle percentage of men was 33.5 (28.4-37.4) and of women 29.9 (25.1-33.4). Looking at the relationship between body fat percentage and lung function, patients with a higher body fat percentage (women: 36-42%, men: 25-30%) had better lung function results (FEV1), better quality of life (CAT) and fewer exacerbations (see Table 2). Muscle percentage correlated also significantly with the 6-minute walking distance (6MWD: ϱ=0.514; p <0.001) and with the quality of life (CAT: ϱ=–0.344; p <0.001).

Table 2. Characteristics of the COPD patients by body fat percentage categories

BMI categories (kg/m²)	Body fat percentage								p-value
	Lean (n, %)		Healthy (n, %)		Overweight (n, %)		Obese (n, %)		
	Men <13	Women <24	Men 13–24	Women 24–35	Men 25–30	Women 36–42	Men ≥ 30	Women ≥42	
Underweight (n=13)	5 (38.46)	5 (38.46)	2 (15.38)	0	1 (7.69)	0	0	0	<0.001
Normal (n=43)	6 (13.95)	8 (18.60)	7 (16.28)	5 (11.62)	2 (4.65)	8 (18.60)	7 (16.27)	0	<0.001
Overweight (n=27)	0	0	3 (11.11)	2 (7.40)	2 (7.40)	6 (22.22)	11 (40.74)	3 (11.11)	<0.001
Obese (n=37)	0	0	2 (5.40)	2 (5.40)	0	6 (16.21)	12 (32.43)	15 (40.54)	<0.001
CAT (points)	31 (28-36)	28 (27-31)	31 (26-34)	28 (23-29)	23 (5-27)	26 (23-32)	23 (18-26)	29 (23-31)	0.029
6MWD (m)	270 (200-278)	250 (200-325)	325 (285-409)	225 (212-345)	390 (125-390)	284 (220-364)	325 (293-371)	255 (132-307)	0.261
FEV_1 (ref%)	32.5 (27-36)	37 (33-49)	47 (41-53)	49 (30-58)	44 (26-44)	45 (39-60)	41 (30-52)	42 (31-53)	0.237
Exacerbation (n)	1 (0-2)	1 (0-1)	1 (0-1)	1 (0-1)	0 (0-1)	1 (0-1)	1 (0-1)	1 (0-2)	0.139

Data are presented as median (IQR) or as frequency and percentage; CAT: COPD Assessment Test; FEV1: forced expiratory volume in 1 s post-bronchodilator; BMI: body mass index; 6MWD: six-minute walking distance; p <0.05 means the two indicators were significantly correlated

Discussion

The aim of our study was to assess the nutritional status of COPD patients and to describe the interrelations of body composition and the quality of life. We found that underweight COPD patients had poorer lung function, poorer quality of life and lower exercise tolerance than normal/overweight patients and patients with higher muscle percentage had a better quality of life and higher exercise tolerance.

Researchers are increasingly highlighting that patients with COPD require a holistic approach from health care professionals, who need to consider not only basic medical parameters but also other indicators that affect overall well-being, i.e. identifying factors that potentially positively influence their quality of life and incorporate them into a comprehensive treatment programme [13-15]. One of these very important prognostic and modifiable factors is malnutrition, which is common in COPD (up to 40%) and is often associated with poor prognosis [16], poor quality of life, increased exacerbations, longer hospital stays and increased costs

of healthcare [17]. Timely screening and initiation of nutritional therapy can lead to significant improvements in respiratory function, workload tolerance and quality of life, as well as they reduce morbidity and mortality in COPD patients, and low BMI has been shown as an independent risk factor for COPD patients' mortality [18-20]. Our study also highlights that body composition is associated with lung function, exercise tolerance and patients' quality of life, which is in harmony with other previous studies [21, 22]. It is also important to mention that the relationship between body composition and the number of exacerbations is a two-way process, because exacerbation increases the level of inflammatory parameters in the blood e.g. tumour necrosis factor α (TNFα), IL-6, which can lead not only to endothelial dysfunction but also to muscle loss, muscle atrophy and other comorbidities in COPD e.g. diabetes, atherosclerosis, osteoporosis [21-23].

Muscle wasting and malnutrition are independent risk factors for COPD mortality. Research has shown that BMI is not sufficient for multidimensional assessment of COPD patients [21-23], i.e. to the BODE (body mass index, airflow obstruction, dyspnoea, exercise capacity) index, it is recommended to add an assessment of body composition. Body composition can be assessed using simple non-invasive bioelectrical impedance analysis (BIA) body composition analysers [24, 25], a well-estimated and still commonly used method is anthropometric measurement, categorised in 1981 by Bishop et al. in tables of percentile values of carcass volume and skinfold thickness, based on sex and age [26]. A third method is the use of imaging studies (DEXA, dual energy X-ray absorptiometry; CT, computed tomography; MRI, magnetic resonance imaging; ultrasound measurements) [27, 28], which are also proposed to assess the effectiveness of pulmonary rehabilitation [29]. With regular body composition assessment and effective intervention, disease progression can be reduced, abnormal body composition can be managed, which has a positive impact on morbidity, improves treatment efficacy, reduces exacerbations, length and cost of hospital stay, and improves quality of life [3, 21, 29].

Nutritional status plays a significant role in the progression of COPD and diet therapy should therefore be an essential part of treatment. Patients with a good nutritional status are more likely to maintain and improve their health status, which has an impact on their quality of life, while poor nutritional status reduces the chance of survival [30]. The detection of malnutrition and the establishment of an adequate nutritional status are very important for optimal therapeutic management [31, 32]. Weight loss in patients with COPD should be monitored every 6 to 12 months, as an appropriate diet and regular exercise can improve the quality of life of patients.

Half of our study participants (52%) experienced weight loss an average of 2.9 kg in the previous 12 months; this is consistent with previous studies found weight loss in 10-15% of patients with mild COPD and about half of the patients with severe COPD. Notably, severely malnourished participants experienced greater weight loss than those who were mildly malnourished [33].

Conclusions

COPD patients are particularly at risk of developing abnormal nutritional status due to the inflammatory nature of their disease and restricted diet, which can significantly affect their disease prognosis. Thus, attention should be paid not only to the consequences of excessive obesity (metabolic syndrome, hypertension, elevated blood sugar) but also to the consequences of malnutrition (energy and protein deficits). In therapy, the most effective and scientific way of preventing malnutrition is to monitor regularly the body composition.

Limitation of the study

Due to the cross-sectional nature of the study, it is not clear whether further weight loss continued in patients. Limitations of our study include the small number of cases, the cross-sectional study and the single-centre enrolment, therefore further studies and data analyses are needed to provide scientific evidence for the above findings and to disseminate them in widespread practice.

Conflict of interest: The authors have no conflicts of interest.

List of abbreviations
6MWT = six-minute walk test; BMI = body mass index; BODE = body mass index, airflow obstruction, dyspnea, exercise capacity; CAT = COPD Assessment Test; COPD = Chronic Obstructive Pulmonary Disease; CT = computed tomography; DEXA = dual energy X-ray absorptiometry; FEV1 = forced expiratory volume in the first second; FVC = forced vital capacity; GOLD = Global Initiative for Chronic Obstructive Lung Disease; IL-6 = interleukin 6; MRI = magnetic resonance imaging; TNFα = tumour necrosis factor α;

Resumo

Interrilatoj de korpa konsisto kaj vivokvalito en kronika obstrukca pulmomalsano (COPD) estas gravaj, ĉar malalta korpa masa indekso (BMI) kaj muskola atrofio estas bazaj faktoroj de malalta ekzerckapablo kaj havas fidindan prognozan valoron de la progresanta malsano. La celo de nia studo estis taksi kiel korpa konsisto influas la vivokvaliton, ekzercan kapablon kaj spiran funkcion de pacientoj kun COPD.

Ni faris korpan komponan mezuradojn ĉe 120 pacientoj kun COPD de la Nacia Koranyi-Instituto pri Pneŭmologio en Budapeŝto inter la 1-a de februaro 2019 kaj la 1-a de februaro 2020, uzante la analizilon de korpa komponado de OMRON Healthcare BF511. La enketilo pri Taksa Testo de COPD-specifa malsano (CAT) mezuris la kvaliton de vivo; spira funkcio kaj antropometriaj datumoj estis ĉerpitaj el la elektronika sanrekorda sistemo.

Malpezaj pacientoj (10.8%) estis malpli da laborŝarĝo (6MWD (m) 250 kontraŭ 320; p = 0.098) kaj havis signife pli malaltan vivokvaliton (CAT: 32 (29-36) kontraŭ 28 (23.5-30) vs 24 (16-30); p=0.004), ol normalaj aŭ tropezaj pacientoj. Tiuj kun pli alta korpa grasa procento (virinoj: 36-42%, viroj: 25-30%) havis pli bonan pulman funkcion (FEV1) kaj signife pli bonan vivokvaliton (CAT). Muskola procento korelaciis ankaŭ signife kun 6-minuta marŝdistanco (6MWD: ρ=0.514; p <0.001) kaj vivokvalito (CAT: ρ=–0.344; p <0.001).

Niaj rezultoj sugestas, ke mezurado kaj taksado de korpa konsisto estas utilaj por administri COPD-pacientojn kaj devus rutine esti faritaj dum terapio, tial ni proponas aldoni korpan komponan taksadon al la COPD-graveca takso (BODE-indekso).

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