The effect of body mass index on functional parameters and quality of life in COPD patients

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ÖZET

KOAH'ta beden kitle indeksi ile fonksiyonel parametreler ve yaşam kalitesi arasındaki ilişki

Kronik obstrüktif akciğer hastalığı (KOAH) olan hastalarda malnütrisyon, solunum kas gücünde bozukluğa yol açarak dispne ve egzersiz intoleransını daha belirgin hale getirir, yaşam kalitesini bozar. Çalışmamızda, düşük ve normal beden kitle indeksi (BKİ)'ne sahip stabil KOAH hastalarında dispnenin ciddiyeti, solunum fonksiyon testleri (SFT), arter kan gazları (AKG), solunum kas gücü indeksi, egzersiz kapasitesi (EK) ve yaşam kalitesi (YK) açısından farklılık olup olmadığı prospektif olarak incelendi. Nisan 2003-Haziran 2004 tarihleri arasında çalışmaya alınan 65 KOAH'lı hastanın yaş ortalaması 63.4 ± 9.6 olup, tümü erkekti. Olgular, BKİ < 21 olanlar (grup 1) ve BKİ= 21-28 olanlar (grup 2) olmak üzere iki gruba ayrıldı. Tüm olgulara SFT (spirometrik ölçümler, maksimum inspiratuar ve ekspiratuar basınçlar, difüzyon testi), AKG ölçümü, "Modified Medical Research Counsil (MMRC)" dispne skalası ile dispne skorlaması, altı dakika yürüme testi (6 DYT) ile EK belirlenmesi, "St. George Respiratory Questionaire (SGRQ)" Türkçe versiyonu ile YK değerlendirilmesi yapıldı. Olguların 29 (%44.6)'u düşük, 36 (%55.4)'sı normal BKİ'ye sahip olup, MMRC dispne skoru birinci grupta daha yüksek olmakla birlikte bu fark istatistiksel olarak anlamlı değildi (p= 0.074). Birinci grupta difüzyon kapasitesi (DLCO) ve %DLCO değerleri, solunum kas gücü parametrelerinden PE_{max}, $\%PE_{max}$, solunum kas gücü indeksi (Respiratory Muscle Strength= RMS), %RMS değerleri anlamlı derecede düşük bulundu (p< 0.05). AKG değerleri, 6 DYT sonuçları ve SGRQ semptom skorlarında iki grup arasında farklılık tespit edilmedi. Sonuç olarak; KOAH'lı hastalarda BKİ ile dispne düzeyi ve solunum kas gücü yakından ilişkili olup, BKİ düşük olgularda medikal tedavinin yanı sıra nütrisyonel desteği de içeren pulmoner rehabilitasyon programlarının uygulanması önemlidir.

Anahtar Kelimeler: *KOAH, beden kitle indeksi, dispne, solunum kas gücü, yaşam kalitesi, solunum fonksiyon testleri, malnütrisyon.*

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SUMMARY

The effect of body mass index on functional parameters and quality of life in COPD patients

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Malnutrition increases dyspnea and exercise intolerance in chronic obstructive pulmonary disease (COPD) patients by effecting respiratory muscle strength (RMS) and thereby decreasing quality of life (QoL). This is a prospective study conducted to find out the differences due to pulmonary function tests (PFT), arterial blood gases (ABG), RMS, exercise capacity (EC) and QoL in COPD patients having low and normal body mass index (BMI). The study was carried out between April 2003-June 2004 and included 65 male COPD patients with a mean age of 63.4 ± 9.6. The patients were grouped into 2: Low BMI group (BMI < 21) and normal BMI group (BMI= 21-28). All patients were investigated with PFT (spirometry, maximal inspiratory and expiratory pressures, diffusion capasity), ABG analyses, Modified Medical Research Council (MMRC) dyspnea scale, determination of EC by 6 minutes walking test (6 MWT) and determination of QoL by Turkish version of St. George Respiratory Questionnaire (SGRQ). Of these cases, 29 (44.6%) had low and 36 (55.4%) had normal BMI; MMRC was higher in the first group without statistical significance (p= 0.074). The first group demonstrated significantly lower diffusion capacity (DLco) and DLco%, PE_{max}, PE_{max}%, RMS and RMS% (p< 0.05). ABG analyses, 6 MWT results and SGRQ symptom scores revealed no significant difference. As a conclusion, BMI is closely related to dyspnea score, RMS and QoL in COPD patients, therefore in patients with low BMI pulmonary rehabilitation programs including nutritional support should accompany medical treatment.

Key Words: *COPD, body mass index, dyspnea, respiratory muscle strength, quality of life, pulmonary function tests, malnutrition.*

Chronic obstructive pulmonary disease (COPD) is a disease consisting of chronic bronchitis and emphysema and characterised by airway hyperreactivity and progressive airflow limitation that is not fully reversible (1-3).

Although COPD primarily effects the lungs, it also produces systemic consequences such as nutritional changes, skeletal-muscular dysfunction and cardiovascular and neurological effects (4).

Dyspnea, which is the most significant symptom restricting quality of life (QoL) and exercise capacity, does not always correlate with the degree of airway obstruction (5-7). This is due to the fact that, not only dyspnea but also leg-muscle fatigue effects the patient's physical activity (4,6,8). For this reason, assessment of the severity of the disease and follow up medical treatment and pulmonary rehabilitation programs require evaluation of disability, exercise capacity and QoL. Subjective measurement of dyspnea is made by dyspnea scales, QoL questionnaires and 6 minute walking tests (6 MWT) (4,9-11).

Malnutrition is a frequent complication in COPD and an important predictor of functional capacity, morbidity and mortality (4,5,12-23). In 1968 Filey et al. grouped COPD patients as pink puffers (emphysematous type) and blue bloaters (chronic bronchitis type). Weight loss is a characteristic finding in emphysematous type (5,15,16,24-26).

Malnutrition significantly reduces respiratory muscle strength and endurance resulting in respiratory muscle dysfunction due to chronic airflow limitation and hyperinflation, exercise intolerance and decrease in QoL (1,5,21-24). Therefore COPD treatment should cover nutritional support in order to increase QoL and functional capacity (1).

Nutritional status is evaluated by antropometric [body mass index (BMI), triceps skin fold, BMI without fat], immunological (total lymphocyte count, lymphocyte subtypes, delayed type skin reactions) parameters and calculation of basal energy expenditure and respiratory muscle strength (RMS) is evaluated by maximum inspiratory (PI_{max}) and maximum expiratory (PE_{max}) pressures (1,3,27).

The aim of our study was to find out the differences due to severity of dyspnea, pulmonary function tests (PFT), arterial blood gases (ABG), respiratory muscle strength, exercise capacity and QoL between stable COPD patients with decreased and normal BMI.

MATERIALS and METHODS

The study population consisted of 65 COPD patients with FEV_1 < 80%, FEV_1/FVC < 70% and BMI < 28 who referred to our chest diseases outpatient clinic between April 2003 and June 2004. All patients were previously diagnosed as COPD due to history, physical examination, radiological and spirometric data according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines and had moderate or severe COPD at the enrollment (28). The exclusion criteria included presence of mixed obstructive and restrictive lung disease, diseases effecting nutritional status and body weight such as malignancy, malabsorbtion, endocrine disorders, chronic renal failure, cardiac or neurological disorders, COPD acute exacerbation and use of systemic steroids in last two months. All patients were evaluated with history, physical examination, routine blood tests and chest X-rays. BMI was calculated as weight divided by height squared (kg/m^2). Patients with BMI < 21 were considered as "underweight" group and patients with BMI 21-28 were grouped as "normal weight" (5). PFTs were measured due to ATS criteria, using V_{max} series 2130, sensor Medics Corp. USA with the patient in upright position (29). Forced vital capacity (FVC) (absolute and %predicted value), forced expiratory volume in first second (FEV_1) (absolute and %predicted value), FEV_1/FVC ratio, maximal voluntary ventilation (MVV), absolute and %predicted values for single breath CO diffusing capacity (DL_{CO}), maximal inspiratory pressure (PI_{max}= MIP), maximal expiratory pressure (PE_{max}= MEP) and RMS were taken into consideration. Maximal pressures were the pressures measured at maximal inspiration following an expiration to residual volume level (PI_{max}) and maximal expiration following an inspiration to total lung capacity level (PE_{max}) each maintained at least one second. Expected values for PI_{max} and PE_{max} were calculated according to European Cool Steel and RMS was calculated from (PI_{max} + PE_{max})/2 (5,30). Arterial blood samples were drawn from radial or femoral arteries, patient breathing room air and ABG analysis was performed with ABL 555, Radiometer Copenhagen.

Severity of dyspnea was assessed according to Turkish version of modified Medical Research Council (MMRC) dyspnea scale (Table 1) (5,31).

Exercise performance was determined using 6 MWT (32). The test was performed by allowing the patient walk as far as possible for 6 min.

Quality of life was assessed by Turkish version of St. George Respiratory Questionnaire (SGRQ) (1). Patients answered the questionnaire concerned with symptoms, activity and impacts in 20 min and total scores were calculated. Values ranged from 0 to 100, with 0 indicating no impairment and 100 indicating the worst health status. Differences between two groups due to severity of dyspnea, PFT, ABG, RMS, 6 MWT and QoL were analysed.

Table 1. MMRC dyspnea scale.

Effect	Grade
• Not troubled by shortness of breath except with strenuous exercise	0
• Troubled by shortness of breath when hurrying on the level or walking up a slight hill	1
• Walks slower than people of the same age on the level because of shortness of breath	2
• Has to stop because of shortness of breath when walking at own pace on the level	3
• Stops for breath after walking about 100 m or after a few minutes on the level	4

Statistical Analysis

Statistical Package for Social Sciences (SPSS) for Windows 10.0 was used for statistical analysis. Besides descriptive statistical methods (mean, standard deviation), we applied Mann Whitney U test, Chi-square test and Pearson correlation test, $p< 0.05$ was considered to be significant.

RESULTS

The study population consisted of 65 male patients with a mean age of 63.38 (43-83). All patients were ex-smokers for at least one year with smoking history of 20-160 pack years. Of these, 29 (44.6%) had BMI < 21 and 36 (55.4%) had BMI= 21-28. Mean age of these two groups was similar ($p> 0.05$) (Table 2).

Regarding ABGs, exercise capacity measured by 6 MWT and QoL according to SGRQ, symptoms, activity, impact and total scores, there was no statistically significant difference between low and normal BMI groups (Table 3). According to MMRC dyspnea scale, dyspnea score was higher in the low BMI group without statistical significance (p= 0.074) (Figure 1, Table 3).

PFT results revealed that DLCO and DLCO% values were lower in low BMI group (p= 0.011 and p= 0.004 respectively). Regarding standard spirometric measurements, there was no significant difference between two groups ($p> 0.05$) (Table 4). Respiratory muscle strengths were lower than predicted values in both groups. PI_{max} and PI_{max}% values were similar whereas PE_{max} (p= 0.003), PE_{max}% (p= 0.003), RMS (p= 0.011) and RMS% (p= 0.009) values were lower in the low BMI group (Table 4).

When correlation between BMI and other parameters evaluated, it was found that there is no significant correlation between BMI and FVC,

Table 2. Age, height, weight and BMI distribution of the cases (mean ± SD).

	BMI < 21 n= 29 (44.6%)	BMI= 21-28 n= 36 (55.4%)	p
Age	66.24 ± 8.31	61.08 ± 10.13	0.06
Height	171.28 ± 7.58	166.86 ± 6.02	**0.015**
Weight	58.14 ± 5.94	71.00 ± 7.03	**< 0.001**
BMI	19.910 ± 0.985	25.72 ± 1.75	**< 0.001**

BMI: Body mass index.

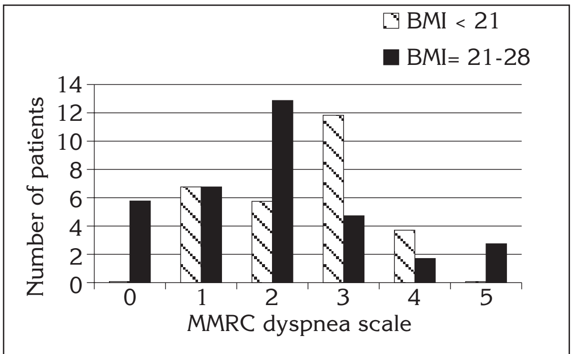

Figure 1. Distribution of low and normal BMI group patients according to dyspnea scales.

Table 3. ABG, 6 MWT, QoL and dyspnea scores in normal and underweight groups.

	BMI < 21 (mean ± SD)	BMI= 21-28 (mean ± SD)	p
PaO_2	66.93 ± 10.26	68.80 ± 11.58	0.60
$PaCO_2$	43.65 ± 5.37	43.97 ± 5.73	0.87
pH	7.39 ± 0.03	7.39 ± 0.03	0.94
SaO_2 (%)	90.98 ± 6.32	92.20 ± 3.83	0.48
6 MWT	261.02 ± 93.42	279.83 ± 86.77	0.34
SGRQ symptom score	52.28 ± 23.53	50.36 ± 19.92	0.69
SGRQ activity score	56.69 ± 27.91	55.03 ± 24.99	0.70
SGRQ impact score	37.24 ± 23.83	35.81 ± 22.82	0.92
SGRQ total score	46.08 ± 22.24	42.64 ± 21.68	0.49
MMRC dyspnea score	2.45 ± 1.02	1.97 ± 1.42	**0.07**

ABG: Arterial blood gases, 6 MWT: Six minute walking test, Qol: Quality of life, BMI: Body mass index, SGRQ: St. George Respiratory Questionnaire, MMRC: Modified Medical Research Council.

Table 4. Pulmonary function tests and respiratory muscle strength parameters in normal and underweight groups.

	BMI < 21 (mean ± SD)	BMI= 21-28 (mean ± SD)	p
FVC (L)	3.10 ± 0.60	3.07 ± 0.71	0.65
FVC%	84.40 ± 13.95	86.39 ± 19.23	0.80
FEV_1 (L)	1.35 ± 0.41	1.44 ± 0.42	0.50
FEV_1%	47.51 ± 13.95	51.42 ± 15.07	0.28
FEV_1/FVC	43.78 ± 10.21	47.38 ± 9.84	0.19
MVV (L/min)	47.59 ± 15.10	52.16 ± 16.06	0.22
DL_{CO} (L/min/mmHg)	23.37 ± 21.58	28.29 ± 22.97	**0.011**
DL_{CO} %	62.58 ± 24.88	81.22 ± 26.2	**0.004**
PI_{max} (cmH_2O)	63.24 ± 19.11	70.94 ± 23.66	0.13
PI_{max}%	59.17 ± 17.52	65.53 ± 20.78	0.12
PE_{max} (cmH_2O)	83.14 ± 19.13	104.89 ± 34.16	**0.003**
PE_{max}%	41.79 ± 9.60	51.58 ± 16.36	**0.003**
RMS (cmH_2O)	73.17 ± 15.67	86.80 ± 26.70	**0.011**
RMS%	50.10 ± 11.12	58.31 ± 16.21	**0.009**

MVV: Maximal voluntary ventilation, BMI: Body mass index.

FVC%, FEV_1, FEV_1%, FEV_1/FVC, MVV, DL_{CO}, PI_{max}, %PI_{max}, PaO_2, $PaCO_2$, pH and SaO_2 ($p > 0.05$), whereas there is statistically significant correlation between BMI and DL_{CO}% (p= 0.004, r= 0.356), PE_{max} (p= 0.003, r= 0.357), PE_{max}% (p= 0.003, r= 0.359), RMS (p= 0.007, r= 0.330), RMS% (p= 0.007, r= 0.337) (Table 5).

DISCUSSION

In COPD patients, malnutrition is associated with significant impairment in respiratory muscle strength and endurance, increased airflow limitation and therefore aggravation in already existing respiratory muscle dysfunction caused by hyperinflation (5). Sahebjami and Sathianpi-

Table 5. Correlation between BMI and PFT, RMS, ABG, 6 MWT, QoL and dyspnea scores.

Parameter	Correlation coefficient (r)	p	Parameter	Correlation coefficient (r)	p
FVC	0.010	0.93	RMS	0.330	**0.007**
FVC%	0.089	0.47	RMS%	0.337	**0.007**
FEV_1	0.091	0.47	PaO_2	0.030	0.81
FEV_1%	0.125	0.32	$PaCO_2$	0.076	0.54
FEV_1/FVC	0.135	0.28	pH	-0.053	0.67
MVV	0.149	0.23	SaO_2 (%)	0.022	0.86
DL_{CO}	0.143	0.25	6 MWT	0.082	0.51
DL_{CO}%	0.356	**0.004**	SGRQ symptom score	-0.027	0.82
PI_{max}	0.240	0.054	SGRQ activity score	0.002	0.98
PI_{max}%	0.231	0.064	SGRQ impact score	-0.002	0.98
PE_{max}	0.357	**0.003**	SGRQ total score	-0.061	0.63
PE_{max}%	0.359	**0.003**	MMRC dyspnea score	-0.14	0.25

BMI: Body mass index, PFT: Pulmonary function tests, RMS: Respiratory muscle strength, ABG: Arterial blood gases, 6 MWT: Six minute walking test, Qol: Quality of life.

tayakul evaluated 90 COPD patients and found out that underweight patients were more dyspneic than normal weight ones (5). Gray-Donald et al. showed that the oxygen cost score, which measures the perceived degree of activity limitation, was not related to nutritional status (21). Similarly, Efthimiou et al. demonstrated that malnourished and well-nourished patients had similar dyspnea scores, however significant clinical improvement was observed in malnourished group after three months of dietary supplementation (33). However, Rogers et al., in evaluation of 15 malnourished COPD patients, found that four months of nutritional support resulted in no significant improvement in oxygen consumption diagram (OCD) scores (26). In our study, underweight and normal weight groups had insignificant differences in MMRC scores.

Malnourished COPD patients have increased airflow limitation and decreased diffusing capacity (4-6,16,18,34). Sahebjami et al. found similar values for FEV_1%, FVC%, FEV_1/FVC and MVV% in underweight and normal weight COPD patients, but significantly lower DL_{CO}% in underweight group. Two studies revealed positive correlation between FEV_1%, FEV_1/FVC and DL_{CO} values and BMI. Gray-Donald et al. showed that nutritional status had small but significant effect on FEV_1, FEV_1/FVC and DL_{CO} values (21). In contrast to mentioned analyses, Efthimiou et al found that pulmonary functions in poorly nourished moderate-severe COPD patients were similar to those in the well-nourished patients and there were no changes in pulmonary functions after three months of dietary supplementation (33). Consistent with previous studies, our results revealed that FVC, FVC%, FEV_1, FEV_1%, FEV_1/FVC and MVV values were similar in COPD patients belonging both low and normal BMI groups however DL_{CO} and DL_{CO}% values were lower in low BMI group.

Rochester and Braun measured PI_{max} and PE_{max} in 32 COPD and 22 healthy subjects and found significantly lower values in COPD. They concluded that reduction in PI_{max} was attributed to decrease in diaphragm length due to hyperinflation. Decrease in PE_{max} was correlated to diffuse muscle weakness (low BMI, hypocalcemia, hypokalemia, systemic corticosteroid use, hypoxemia) (35). Sahebjami, Efthimiou and Schols found lower PI_{max} values in malnourished COPD patients whereas PE_{max} values did not differ significantly (16,33,36). Nutritional support significantly improved PI_{max} and PE_{max} values. Similarly, Creutzberg et al. found that eight week nutritional supplementation therapy improved PI_{max} values significantly (37). In contrast to mentioned studies, in the study of Lewis et al., nutritional status was not found to effect PI_{max} and PE_{max} values and nutritional support did not change anthropometric measures, pulmonary functions or respiratory muscle function. In our study, in contrast to PI_{max} and PI_{max}% values which were not different in lower and normal BMI groups, PE_{max} PE_{max}%, RMS and RMS% values were statistically significantly lower in underweight group when compared to normal weight group.

In COPD, malnutrition causes reduced ventilatory response to hypoxia and hypercapnia, structural and metabolic changes in respiratory muscles and decreased alveoler ventilation, thereby worsens ABG (4,13).

Fiaccadori et al. showed significant inverse relationship between $PaCO_2$ and body weight (38). In an analysis, malnourished subjects had significantly lower PaO_2 values (27). In several other studies, BMI did not effect ABG significantly (5,16,17). Likewise, in our study, PaO_2, $PaCO_2$, pH and SaO_2 levels were similar in both underweight and normal weight groups.

Malnutrition is associated with structural and metabolic changes in peripheral and respiratory muscles, therefore aggravates pre-existing dyspnea and exercise intolerance and impairs quality of life (1,5,21,22,24). Schols et al. found that FFM correlated with the distance walked in 12 min (39). Several studies revealed no correlation between body weight and 6 and 12 MWT, however nutritional support significantly increased the distance walked (26,36,37). Gray-Donald et al., in a study of 135 COPD patients showed no correlation between body weight and results of 6 MWT and short questionnaire for QoL (21). Similarly, Efthimiou et al. also found no differences in 6 MWT, but scores of QoL were better in normal weight patients (33). Six MWT and QoL scores improved significantly after three month nutritional support. Our results demonstrated no significant correlation between BMI and 6 MWT, SGRQ symptom, activity, impact and total scores ($p > 0.05$).

As a conclusion, underweight COPD -altough not with a statistical significance- patients are more severely dyspneic, have lower DL_{CO}, PE_{max} and RMS values. Malnutrition causes severe disability. Aims of COPD treatment should include improvement in exercise capacity and QoL in adition to survival benefits. PFT and ABG should be accompanied by detailed analysis of nutritional status and pulmonary rehabilitation programs including both medical treatment and nutritional support should be considered for the patients in order to help them to use their capacity as much as possible.

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