Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2021;10(3):816-21

Relationship of obesity with exercise capacity, quality of life and fatigue level in chronic obstructive pulmonary disease

Alp Ozel[1], Eylem Tutun Yumin[1], Suat Konuk[2], Tuncer Tug[2]

[1]*Bolu Abant Izzet Baysal University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Bolu, Turkey*
[2]*Bolu Abant Izzet Baysal University, Faculty of Medicine, Department of Chest Diseases, Bolu, Turkey*

Received 17 January 2020; Accepted 01 February 2021
Available online 20.05.2021 with doi: 10.5455/medscience.2020.06.109

Copyright@Author(s) - Available online at www.medicinescience.org
Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Abstract

This study was planned to investigate the relationship of obesity with exercise capacity, quality of life, and fatigue level in Chronic Obstructive Pulmonary Disease (COPD). 109 individuals with COPD were included in the study. Individuals were stratified into three groups as normal (18.5≤, ≤24.9 kg/m^2, n=34), overweight (25≤, ≤29.9 kg/m^2, n=43) and obese (>30 kg/m^2, n=32). After taking socio-demographic information of the individuals, The Shuttle Walking Test was used to measure exercise capacity, St. George Respiratory Questionnaire to measure quality of life, and the Fatigue Severity Scale to measure fatigue levels. The average age and BMI of normal, overweight and obese individuals participating in the study were 60.58±13.21 years, 21.48±1.83 kg/m^2; 61.83±11.33 years, 26.98±1.50 kg/m^2 and 57.55±12.85 years, 33.46±3.93 kg/m^2 respectively with age being similar between the groups ($p>0.05$). In the correlation analysis, there was a significant relationship between exercise capacity and fatigue severity ($r= -0.532$, $p= 0.007$), SGRQ activity parameter ($r= -0.508$, $p= 0.011$) in individuals with obesity ($p<0.05$). No relation was observed in these parameters in the normal and overweight COPD group ($p> 0.05$). There was a relationship between fatigue severity and all sub-parameters of SGRQ in all 3 groups ($p<0.05$). In obese individuals with COPD, BMI was found to be related to the individual's exercise capacity. It was found that exercise capacity in individuals with obesity is related to fatigue severity and quality of life. For this reason, it was thought that rehabilitation approaches to control weight and increase exercise capacity may positively affect individuals' fatigue status and quality of life.

Keywords: COPD, Obesity, Fatigue, Exercise Capacity, Quality of Life

Introduction

Chronic obstructive pulmonary disease (COPD) is a disease characterized by the presence of airflow limitation, which is not completely reversible and is generally progressive. The change in disease progression is often expressed by the rate of decline in FEV1 and this change is interpreted as the natural history of COPD. According to current estimates, the global burden of obesity and mortality in COPD will increase [1]. COPD was the fifth leading cause of death in the world in 2001 and is expected to be the third most common cause of death in 2020 [2].

While Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD) guidelines are being utilized for the diagnosing and estimation of severity; weight classifications are based on body mass index (BMI) defined by the World Health Organization (WHO). Although little is known about the underlying relationship between obesity and COPD, the potential link is getting clearer every year [3]. Obesity in COPD patients results in a decrease in daily life activity levels [4]. Also, truncal obesity risk can increase due to repeated systemic corticosteroid treatments [5]. Steuten et al. evaluated the obesity prevalence in primary care COPD patients; the overall prevalence was 18%, with the highest prevalence being in GOLD I and II with 16-24% and the lowest in GOLD IV with 6%. [6]. Eisner et al. reported a higher prevalence; with BMI being >30 kg/m2 in 54% of patients, more than doubling the general prevalence of obesity in the region [7]. The prognostic value of nutritional status in COPD is well established. Low BMI is associated with mortality independent of disease severity [8]. Being overweight or obese is associated with reduced mortality in COPD; this phenomenon is commonly referred to as the "obesity paradox". Yet; obesity can reduce the health-related quality of life (HRQoL) and causes increased physical restrictions [9]. Obesity is associated with factors such as reduced thoracic compliance,

***Corresponding Author:** Suat Konuk, Bolu Abant Izzet Baysal University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Bolu, Turkey E-mail: suatkonukk@windowslive.com

increased airway resistance, and increased respiratory work, thus worsening symptoms of dyspnea and wheezing due. [10].

COPD is considered a systemic disorder [11]. Therefore, it is important to research multidimensionally how various parameters other than FEV1 alter. Exercise capacity is a crucial outcome in COPD because it is a determinant of impaired health status and has a strong relationship with poor quality of life [12]. Clinical experience shows that combined limiting/obstructive deficits seen in obese COPD patients can result in worsening symptoms and activity limitations [3, 13]. Studies have shown that exercise capacity decreases due to COPD [14-16]. Besides, fatigue and dyspnea are common symptoms in COPD. The fatigue severity in patients with asthma and emphysema is 2.9 times higher than in healthy adults. Also, fatigue and dyspnea are the primary symptoms that limit exercise tolerance in COPD. With the addition of obesity to the COPD picture, this situation becomes more complex [17]. Given the wide pathophysiological heterogeneity of COPD and the presence of serious comorbidities, it is important to investigate exercise capacity, quality of life, and fatigue level with the addition of obesity to the picture.

This study was planned to investigate the relationship between obesity and exercise capacity, quality of life, and fatigue level.

Material and Methods

Study design and subjects

This is a cross-sectional study. Permission was obtained from the Bolu Abant Izzet Baysal University Human Research Ethics Committee (2016/43). This study included 109 individuals who presented to pulmonology outpatient clinics and were diagnosed with mild to moderate COPD according to GOLD criteria. All patients participating in the study were clinically stable. The patients were stratified into three groups according to WHO BMI classification [18]. Group 1 normal weight (18.5≤, ≤24.9 kg/m2, n= 34), Group 2 overweight (25≤, ≤29.9 kg/m2, n= 43), Group 3 obese (BMI> 30 kg/m2, n= 32).

With the one-way analysis of variance method in determining the participants in the study, it was determined that with the hypothesis that there would be a wide effect size of w= 0.33 between 3 groups, at least 31 people in each group and 93 people in total would be included with 80% power and 5% margin of error. The calculation was carried out with the G-power 3.0.10 program.

Inclusion and exclusion criteria

Inclusion criteria: having been diagnosed with COPD according to the GOLD criteria; stable disease for at least 8 weeks; volunteering to participate. Exclusion criteria: the presence of serious uncontrolled heart disease (heart failure, uncontrolled hypertension, angina or myocardial infarction history, heart valve problems); malignancy; musculoskeletal deformity that may prevent the patient from exercising; or neurological disease (history of cerebrovascular attack, multiple sclerosis, Parkinson's).

Data collection

Socio-demographic information of the individuals participating in the study was recorded. Functional capacity was evaluated with the Incremental Shuttle Walk Test (ISWT). The ISWT was performed according to the standard guidelines described by Singh et al [19]. The cones were placed 9 meters apart. Patients walked a path around the two cones so that the walked distance was about 10 meters. The speed was controlled by an audio signal. Every minute walking speed increased by 0.17 meters/second. The ISWT ends if any one of the following occurs: 1) The patient is too breathless to continue; 2) The patient is >50 cm away from the marker at the beep sound (can be given 1 lap to catch up), or 3) At 85% of predicted maximum heart rate (210 – 0.65xage) [20]. Before and after the ISWT, oxygen saturation was measured with a pulse oximeter (KPTS-01, Seoul, Korea), dyspnea, and fatigue perceptions were recorded using the Modified Borg Scale. Modified Borg Scale (MBS) is a categorical scale that evaluates breathlessness between 0-10 [21]. Patients evaluated breathlessness by selecting the option that most appropriately described their status.

Saint George Respiratory Questionnaire (SGRQ) is a widely used method to evaluate the quality of life in obstructive airway diseases and especially COPD. SGRQ consists of three subscales and total scores. SGRQ scores range from 0-100, with higher scores reflecting the poorer quality of life. The total score summarizes the effect of the disease on the overall state of health [22].

Perceived fatigue was evaluated with the Fatigue Severity Scale (FSS). FSS is a 9-item scale that measures the severity of fatigue from 1 to 7. A score of ≥4 defines severe fatigue [23].

Statistical analysis

Data analysis was performed using SPSS version 20.0 (SPSS Inc, Chicago, USA). Variables were expressed as arithmetic mean ± standard deviation (X±SD), incidence, and percentage. The suitability of variables to normal distribution was examined using the Kolmogorov-Smirnov test.

Descriptive analyzes were given using the mean and standard deviations for normally distributed variables. Since the FVC and SGRQ (Symptoms) values were determined to show normal distribution, these parameters were compared between BMI groups (Normal/Overweight/Obese) using the one-way ANOVA* test. The homogeneity of the variances was evaluated by the Levene test. In cases of a significant difference between the groups, two posthoc comparisons were made using the Tukey test.

Parameters determined without normal distribution were evaluated using the Kruskal-Wallis test. Double comparisons were performed with the Mann-Whitney U test and evaluated using Bonferroni correction. Significant p values are in bold and letters are placed in the upper right of the ($\bar{X}$) values to indicate the differences between groups, indicating the difference between the means in the same line and carrying different letters is significant.

Pearson correlation coefficient and Spearman correlation analysis were used to analyzing the relationships between variables. A P-value below 0.05 was used as a cut-off for statistical significance.

Results

The average age and BMI of normal, overweight, and obese individuals participating in the study were 60.58±13.21 years, 21.48±1.83 kg/m²; 61.83±11.33 years, 26.98±1.50 kg/m² and 57.55±12.85 years, 33.46±3.93 kg/m² respectively (Table 1). The clinical characteristics of the population in the study are given in (Table 2)

In the normal weight group, there was no relationship between the FSS score and the Shuttle walking test (r=-0.036, p=0.848). There was a relationship between the FSS score and SGRQ (Symptoms) (r=0.479, p=0.005), SGRQ (Activity) (r=0.685, p=0.001), SGRQ (Impacts) (r=0.676, p=0.001), and SGRQ (total) (r=0.723, p=0.001) (Table 3).

In the overweight group, there was no relationship between the FSS score and the Shuttle walking test (r=-0.009, p=0.960). There was a relationship between the FSS score and SGRQ (Symptoms) (r=0.724, p=0.001), SGRQ (Activity) (r=0.607, p=0.001), SGRQ (Impacts) (r=0.492, p=0.01), and SGRQ (total) (r=0.554, p=0.001) (Table 4).

In the obese group, there was a relationship between the FSS score and the Shuttle walking test (r=-0.532, p=0.007). There was a relationship between the FSS score and SGRQ (Symptoms) (r=0.482, p=0.005), SGRQ (Activity) (r=0.633, p=0.001), SGRQ (Impacts) (r=0.538, p=0.002), and SGRQ (total) (r=0.573, p=0.001) (Table 5).

Table 1. Demographic information of the individuals

		Normal weight		Overweight		Obese		p
Age (years)		60.58±13.21		61.83±11.33		57.55±12.85		0.390#
BMI (kg/m²)		21.48a±1.83		26.98b±1.50		33.46c±3.93		0.001#
Sex	**Female**	7	%20.6	10	%23.3	23	%71.9	-
	Male	27	%79.4	33	%76.7	9	%28.1	-
Hospitalization (last 3 months)		20	%64.5	23	%53.5	13	%46.4	-

Table 2. Clinical characteristics of individuals in groups

	Normal weight (n=34) X̄±SD	Overweight (n=43) X̄±SD	Obese (n=32) X̄±SD	p
FEV_1 (L)	2.20±0.84	3.74±1.42	2.05±0.61	0.431#
FEV_1 (%)	72.33ᵃᵇ±17.00	66.63ᵇ±16.46	70.03ᵃ±19.32	0.028#
FVC (L)	3.23±0.96	2.91±0.97	2.93±0.76	0.298*
FVC (%)	87.20±17.67	81.04±21.02	85.03±19.32	0.067#
FEV_1/FVC	70.16±11.99	73.31±9.40	70.43±6.03	0.394#
Shuttle walking test (m)	371.94ᵃ±120.79	346.03ᵃᵇ±58.87	312.67b±61.58	0.001#
SGRQ (Symptoms)	71.23ᵃ±20.68	63.87 ᵇ±22.99	56.44ᵃᵇ±21.94	0.029*
SGRQ (Activity)	72.11±35.12	68.13±34.87	75.22±30.21	0.763#
SGRQ (Impacts)	60.68±29.31	55.63±35.82	62.18±28.03	0.781#
SGRQ (Total)	65.71±28.31	60.94±30.93	66.24±24.80	0.786#
FSS	7.04±1.76	6.60±2.20	6.56±2.16	0.675#

*ANOVA; #Kruskal-Wallis test; p<0.05; BMI: Body mass index; FEV_1: Forced expiratory volume in 1 second; FVC: Forced vital capacity; SGRQ: St.George Respiratory Questionnaire; FSS: Fatigue Severity Scale.

Table 3. Normal weight group: the relationship between exercise capacity, quality of life, and severity of fatigue

		Shuttle walking test	SGRQ (Symptoms)	SGRQ (Activity)	SGRQ (Impacts)	SGRQ (Total)	FSS
Shuttle walking test	r	1	-0.113	0.030	0.003	-0.007	-0.036
	p		0.553	0.874	0.987	0.972	0.848
SGRQ (Symptoms)	r		1	0.719	0.657	0.769	0.479
	p			0.001	0.001	0.001	0.005
SGRQ (Activity)	r			1	0.863	0.915	0.685
	p				0.001	0.001	0.001
SGRQ (Impacts)	r				1	0.965	0.676
	p					0.001	0.001
SGRQ (Total)	r					1	0.723
	p						0.001
FSS	r						1
	p						

SGRQ: St.George Respiratory Questionnaire; FSS: Fatigue Severity Scale.

Table 4. Overweight group: the relationship between exercise capacity, quality of life, and severity of fatigue

		Shuttle walking test	SGRQ (Symptoms)	SGRQ (Activity)	SGRQ (Impacts)	SGRQ (Total)	FSS
Shuttle walking test	r	1	0.021	0.041	0.084	0.108	-0.009
	p		0.913	0.930	0.660	0.572	0.960
SGRQ (Symptoms)	r		1	0.519	0.486	0.557	0.724
	p			0.001	0.001	0.001	0.001
SGRQ (Activity)	r			1	0.836	0.897	0.607
	p				0.001	0.001	0.001
SGRQ (Impacts)	r				1	0.979	0.492
	p					0.001	0.010
SGRQ (Total)	r					1	0.554
	p						0.001
FSS	r						1
	p						

SGRQ: St.George Respiratory Questionnaire; FSS: Fatigue Severity Scale

Table 5. Obese group: the relationship between exercise capacity, quality of life, and severity of fatigue

		Shuttle walking test	SGRQ (Symptoms)	SGRQ (Activity)	SGRQ (Impacts)	SGRQ (Total)	FSS
Shuttle walking test	r	1	-0.230	-0.508	-0.357	-0.406	-0.532
	p		0.279	0.011	0.094	0.054	0.007
SGRQ (Symptoms)	r		1	0.574	0.600	0.652	0.482
	p			0.001	0.001	0.001	0.005
SGRQ (Activity)	r			1	0.773	0.849	0.633
	p				0.001	0.001	0.001
SGRQ (Impacts)	r				1	0.977	0.538
	p					0.001	0.002
SGRQ (Total)	r					1	0.573
	p						0.001
SGRQ (Total)	r						1
	p						

SGRQ: St.George Respiratory Questionnaire; FSS: Fatigue Severity Scale.

Discussion

TAs a result of the study, fatigue was associated with quality of life in all three groups of normal-weight, overweight, and obese COPD patients. However, in obese COPD patients, there was also a relationship between exercise capacity, fatigue, and quality of life.

Among the main respiratory complications of obesity are increased need for ventilation, the inefficiency of respiratory muscles, and a decrease in respiratory compliance. Hypoventilation and sleep apnea syndromes commonly develop in obese patients [24]. The final result is a worsening health condition. In obese patients, dyspnea affecting the quality of life has worsened and exercise capacity has decreased. In addition to the cardiopulmonary effects, decreased muscle mass is an important determinant in the decline of exercise capacity with obesity [10]. Obesity is associated with increased exercise dyspnea. Also, obesity creates the need for more metabolic energy as a result of altered respiratory function. It causes additional ventilation during exercise as a direct result of increased body mass [25]. It is difficult to estimate the effect on respiratory muscle/mechanical factors during exercise.

Soth et al. [26] evaluated the maximum exercise capacity with bicycle ergometry in 2625 COPD patients, 450 of whom were obese. The maximum exercise capacity increased with increasing BMI, but the maximum exercise capacity decreased as the BMI increased to the obesity range. Our findings are similar to a study by Enright et al. [27] who found a non-significant relationship between increasing weight in the elderly and 6-minute walking test scores. Contrary to current beliefs, in a previous study, the combination of obesity and COPD has been reported to cause no more dyspnea and exercise limitation compared to normal-weight patients with similar airway limitation, despite more metabolic and ventilation needs [28]. Melda et al. [29] reported that being overweight and obese in COPD had a positive effect on muscle strength and physical activity. Also, despite the increase in metabolic and ventilation needs, obesity has been reported to have potential benefits on exercise tolerance in COPD [30]. In another study [31], cachectic COPD patients were reported to have more dyspnea as a result of decreased respiratory muscle strength.

Seres et al. [32] reported that decreased exercise capacity in morbid obesity was associated with increased oxygen uptake, heart rate, systolic blood pressure, and minute ventilation. They reported that the reason for low exercise capacity was due to the need for more energy to move the increased total body mass. In the literature, studies on respiratory muscle function in patients with normal and overweight COPD gave conflicting results [33, 34].

Domingo et al. [35] demonstrated that health-related quality of life measurements can be used to predict COPD mortality, as patients with worse SGRQ scores were found to have higher mortality. In a previous study, it was reported that approximately three-quarters of stable COPD patients experience fatigue [36]. It has been reported that fatigue affects physical, cognitive, and psychological functioning in individuals with COPD [37]. However, Kouijzer et al. [38] showed that fatigue also caused decreased social functionality, social isolation, feelings of loneliness, and a high mental burden. In our study, there was a correlation between the quality of life and fatigue levels in all three groups. Our results are similar to the literature in light of this information. Fatigue is a very important parameter that adversely affects the life of COPD patients in many ways. Ramachandran et al. [17] reported that obese COPD patients were referred to pulmonary rehabilitation at an earlier stage, but had poorer exercise performance, more disruption in their daily activities, and more fatigue.

This study has some limitations. In our study, detailed analyzes could not be made because body composition was not evaluated in detail. However, the level of fatigue has not been evaluated multidimensionally. Nevertheless, the strengths of our study are the investigation of the relationship between being normal weight, overweight, and obesity in patients with COPD and the parameters of exercise capacity, quality of life, and fatigue, which play a very important role in daily living activities of individuals.

Conclusion

In conclusion, fatigue level was found to be associated with quality of life in normal weight, overweight, and obese COPD patients. However, it was shown that there was a relationship between exercise capacity, fatigue, and quality of life in obese COPD patients. It should be kept in mind that it is important to provide weight control in rehabilitation programs that will be applied to patients with COPD.

Acknowledgments

This study was presented in an oral presentation at the 1st International Health Science And Life Congress 2018.

Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

All authors declare no financial support.

Ethical approval

Bolu Abant İzzet Baysal University Desicion no 2016/43

References

1. Nishida C, Mucavele P. Monitoring the rapidly emerging public health problem of overweight and obesity: the WHO Global Database on Body Mass Index. SCN news. 2005:5-11.
2. Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. Lancet. 1997;349:1498-504.
3. Poulain M, Doucet M, Major GC, et al. The effect of obesity on chronic respiratory diseases: pathophysiology and therapeutic strategies. Cmaj. 2006;174:1293-9.
4. Pitta F, Troosters T, Spruit MA, et al. Characteristics of physical activities in daily life in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2005;171:972-7.
5. Dallman MF, la Fleur SE, Pecoraro NC, et al. Minireview: glucocorticoids—food intake, abdominal obesity, and wealthy nations in 2004. Endocrinology. 2004;145:2633-8.
6. Steuten LM, Creutzberg EC, Vrijhoef HJ, et al. COPD as a multicomponent disease: inventory of dyspnoea, underweight, obesity and fat free mass depletion in primary care. Prim Care Respir J. 2006;15:84.
7. Eisner MD, Blanc PD, Sidney S, et al. Body composition and functional limitation in COPD. Respir Res. 2007;8:7.
8. Landbo C, Prescott E, Lange P, et al. Prognostic value of nutritional status in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1999;160:1856-61.
9. Arterburn DE, McDonell MB, Hedrick SC, et al. Association of body weight with condition-specific quality of life in male veterans. Am J Med. 2004;117:738-46.
10. Parameswaran K, Todd DC, Soth M. Altered Respiratory Physiology in Obesity. Can Respir J. 2006;13:834786.
11. Gross NJ. Extrapulmonary effects of chronic obstructive pulmonary disease. Curr Opin Pulm Med. 2001;7:84-92.
12. Oga T, Nishimura K, Tsukino M, et al. Analysis of the factors related to mortality in chronic obstructive pulmonary disease: role of exercise capacity and health status. Am J Respir Crit Care Med. 2003;167:544-9.
13. Gibson G. Obesity, respiratory function and breathlessness. Thorax. 2000;55:S41.
14. Oga T, Nishimura K, Tsukino M, et al. Exercise capacity deterioration in patients with COPD: longitudinal evaluation over 5 years. Chest. 2005;128:62-9.
15. Zwerink M, van der Palen J, van der Valk P, et al. Relationship between daily physical activity and exercise capacity in patients with COPD. Respir Med. 2013;107:242-8.
16. Ramon MA, Gimeno-Santos E, Ferrer J, et al. Hospital admissions and exercise capacity decline in patients with COPD. Eur Respir J. 2014;43:1018-27.
17. Ramachandran K, McCusker C, Connors M, et al. The influence of obesity on pulmonary rehabilitation outcomes in patients with COPD. Chron Respir Dis. 2008;5:205-9.
18. Flegal KM, Kit BK, Graubard BI. Body mass index categories in observational studies of weight and risk of death. Am J Epidemiol. 2014;180:288-96.
19. Singh SJ, Morgan M, Scott S, et al. Development of a shuttle walking test of disability in patients with chronic airways obstruction. Thorax. 1992;47:1019-24.
20. Vestbo J, Hurd SS, Agustí AG, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med. 2013;187:347-65.
21. Scherr J, Wolfarth B, Christle JW, et al. Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. Eur J Appl Physiol. 2013;113:147-55.
22. Jones PW, Quirk FH, Baveystock CM, et al. A self-complete measure of health status for chronic airflow limitation. Am Rev Respir Dis. 1992;145:1321-7.
23. Inal-Ince D, Savci S, Saglam M, et al. Fatigue and multidimensional disease

severity in chronic obstructive pulmonary disease. Multidiscip Respir Med. 2010. 2010;5:162.

24. Sood A. Altered resting and exercise respiratory physiology in obesity. Clin Chest Med. 2009;30:445-54.

25. Lambert AA, Putcha N, Drummond MB, et al. Obesity is associated with increased morbidity in moderate to severe COPD. Chest. 2017;151:68-77.

26. Soth M OJ, Killian KJ. Body mass index, muscle strength,pulmonary impairment, and exercise capacity in COPD. Proc Am Thorac Soc. 2005;252-9.

27. Enright PL, McBurnie MA, Bittner V, et al. The 6-min walk test: a quick measure of functional status in elderly adults. Chest. 2003;123:387-98.

28. Ora J, Laveneziana P, Ofir D, et al. Combined effects of obesity and chronic obstructive pulmonary disease on dyspnea and exercise tolerance. Am J Respir Crit Care Med. 2009;180:964-71.

29. Sağlam M, Savcı S, Yağlı NV, et al. Relationship between obesity and respiratory muscle strength, functional capacity, and physical activity level in patients with chronic obstructive pulmonary disease. Turk J Physiother Rehabil. 2013;3:1-6.

30. O'Donnell DE, O'Donnell CD, Webb KA, et al. Respiratory consequences of mild-to-moderate obesity: impact on exercise performance in health and in chronic obstructive pulmonary disease. Pulm Med. 2012;2012:818925

31. Sahebjami H, Sathianpitayakul E. Influence of body weight on the severity of dyspnea in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2000;161:886-90.

32. Serés L, López-Ayerbe J, Coll R, et al. Cardiopulmonary function and exercise capacity in patients with morbid obesity. Rev Esp Cardiol. 2003;56:594-600.

33. Arora NS, Rochester DF. Effect of body weight and muscularity on human diaphragm muscle mass, thickness, and area. J Appl Physiol Respir Environ Exerc Physiol. 1982;52:64-70.

34. Edelman NH, Rucker RB, Peavy HH. Nutrition and the respiratory system: Chronic obstructive Pulmonary Disease (COPD). Am Rev Respir Dis. 1986;134:347-52.

35. Domingo-Salvany A, Lamarca R, Ferrer M, et al. Health-related quality of life and mortality in male patients with chronic obstructive pulmonary disease. . Am J Respir Crit Care Med. 2002;166:680-5.

36. Tödt K, Skargren E, Kentson M, et al. Experience of fatigue, and its relationship to physical capacity and disease severity in men and women with COPD. Int J Chron Obstruct Pulmon Dis. 2014;9:17-25.

37. Kouijzer M. Fatigue in patients with Chronic Obstructive Pulmonary Disease: A qualitative study on the perspective of the COPD patient on the impact of fatigue on their daily lives: University of Twente; 2017.

38. Kouijzer M, Brusse-Keizer M, Bode C. COPD-related fatigue: Impact on daily life and treatment opportunities from the patient's perspective. Respir Med. 2018;141:47-51.