

# Anthropometric Indicators Associated with Dyspnea and Spirometric Parameters in Patients with Chronic Obstructive Pulmonary Disease

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**Background:** This study aimed to determine anthropometric indicators associated with dyspnea and spirometric parameters in patients with chronic obstructive pulmonary disease (COPD).

**Materials and Methods:** A cross-sectional and observational study was carried out on 88 patients with COPD, who were visited in an outpatient respiratory clinic of a university hospital during two months. Patient height, weight, body mass index (BMI), waist circumference (WC), mid-upper arm circumference (MUAC), triceps skinfold thickness (TSFT) and subscapular skinfold thickness (SST) were recorded. Also, data on lung function and dyspnea were collected. The association between anthropometric indices and other parameters was studied.

**Results:** Pearson's correlation coefficient showed that forced expiratory volume in one second (FEV1)% predicted was positively correlated with BMI (R=0.239, P<0.05) and MUAC (R=0.431, P<0.01). By applying ANOVA, we found that the relationship between FEV1% predicted and BMI (P=0.007), WC (P=0.019) and MUAC (P<0.001) was statistically significant. Chi-square test showed that there was an association between MUAC and dyspnea (P<0.05).

**Conclusion:** There was a relationship between FEV1% predicted and some anthropometric indices such as BMI, MUAC and WC; also, we found an association between MUAC and dyspnea.

**Key words:** Anthropometry, Chronic obstructive pulmonary disease, Dyspnea, Forced expiratory volume in one second (FEV1)

## INTRODUCTION

Among respiratory diseases, COPD is an important but improvable respiratory condition. It can be one of the main causes of poor quality of life and can lead to death. Because of its high prevalence and high cost of treatment, it has an excessive burden on health care system (1, 2). In addition, COPD has significant systemic complications such as malnutrition, weight loss and peripheral muscle dysfunction (3). The disease is progressively debilitating

but morbidities can be lessened by some measures like quitting smoking, infection control and adequate rehabilitation (2).

Previous studies have provided documents about the relationship of extra-pulmonary manifestations and respiratory status in COPD patients. The occurrence of malnutrition in these patients is 20-50% and it has been noticed as a predictor of clinical features. Also, peripheral muscle dysfunction and wasting are common in these

patients and they are associated with disease severity and mortality (1, 2, 4). Many of the previous studies used BMI as an estimation of nutritional status; whereas, different anthropometric indicators have been measured for assessing the nutritional status and muscle dysfunction in recent studies (5, 6).

This study aimed to focus directly on the anthropometric indicators regardless of factors representing nutritional status of COPD patients. Therefore, we designed the present study to assess anthropometric indicators in relation to spirometric parameters and dyspnea in COPD patients.

## **MATERIALS AND METHODS**

### **Study design and subjects**

We carried out a cross-sectional study to determine anthropometric indices associated with dyspnea and spirometric parameters in COPD patients.

In this study, COPD was defined according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria. COPD was diagnosed when FEV1/forced vital capacity (FVC) ratio was less than 70% even after inhalation of a bronchodilator (7).

The inclusion criteria were stable COPD patients that were visited in the respiratory clinic of Al-Zahra Hospital, Isfahan, during a period of two months. However, patients were excluded if they had any other respiratory disease, confounding inflammatory conditions and malignancies or if they were not willing to participate in this study. Finally, 88 patients were included in our study.

The study was approved by the Research Ethics Committee of Isfahan University of Medical Sciences and all the participants signed informed consent forms.

### **Measurements**

In our study, data were obtained in 3 ways as follows:

First, by means of an interview, we collected some information about demographic characteristics, smoking status and dyspnea. For evaluating dyspnea, we used the visual analog scale (8). The severity of dyspnea (in a scale

of 0 to 10) was divided into three categories: 1-3 for mild, 4-6 for moderate, and 7-10 for severe dyspnea.

Second, we measured anthropometric indices including BMI, WC, MUAC, TSFT and SST. The BMI was calculated by dividing the weight in kilograms by the height squared in meters. We measured the WC in the transverse plane right on top of the iliac crest (9). MUAC was measured with a millimeter tape at the midpoint of the non-dominant arm, between the olecranon and acromion (10). For the last two parameters, we grasped a fold of our patient's skin between our thumb and index finger in a way that it included skin and subcutaneous fat, but no muscle or fascia. The contact surface of the caliper was put at a 90-degree angle to the skinfold roughly 1cm below the fingers. For determining TSFT, skinfold was taken at the posterolateral region in the middle of the acromial-olecranon line while the non-dominant arm was in supination position (11). The SST was measured 1 to 2 cm below the inferior angle of the scapula (the bottom of the shoulder blade) (12). Finally, lung function was assessed by means of spirometry equipment (Ferrari KOKO Louisville, CO, USA) and we measured FEV1, FVC, and FEV1/FVC.

### **Statistical analysis**

The data analysis was done using SPSS version 22. Dyspnea and spirometric parameters were included in the analysis as dependent variables. Anthropometric indicators were analyzed as independent variables. One-way ANOVA with post-hoc test and Chi-square test were applied for quantitative and qualitative variables, respectively. Correlation between parameters was evaluated using the Pearson's correlation coefficient ( $r$ ). A P value of  $<0.05$  was considered statistically significant.

## **RESULTS**

The study group consisted of 88 COPD patients (94.3% males, 5.6% females).

The Pearson's correlation test showed that FEV1% predicted and BMI were positively correlated ( $R=0.239$ ,  $P<0.05$ ). Also FEV1% predicted was correlated with MUAC ( $R=0.431$ ,  $P<0.01$ ). These are shown in Table 1.

**Table 1.** Relationship between anthropometric indicators and spirometric parameters (Pearson's correlation test)

Anthropometric indices	FEV1	FVC	FEV1/FVC
<b>BMI</b>	0.239*	0.195	0.186
<b>WC</b>	0.164	0.124	0.127
<b>MUAC</b>	0.431**	0.367**	0.289**
<b>TSFT</b>	0.160	0.136	0.082
<b>SST</b>	0.199	0.151	0.131

FEV1: Forced expiratory volume in 1 second, FVC: Forced vital capacity, BMI: Body mass index, WC: Waist circumference, MUAC: Mid-upper arm circumference, TSFT: Triceps skin fold thickness, SST: Subscapular skinfold thickness., \* Correlation is significant at 0.05 level, \*\* Correlation is significant at 0.01 level

The COPD patients were classified according to each anthropometric indicator and were analyzed with one-way ANOVA for assessing spirometric parameters (Table 2).

For BMI, patients were categorized as follows (13): Underweight with BMI<20, normal with 20≤BMI<25, and overweight/obese for BMI≥25 kg/m<sup>2</sup>. We found that the lower the BMI, the lower the FEV1 (P=0.007). The post-hoc Tukey's test indicated that there were significant differences between underweight and overweight/obese groups, and also between normal and overweight/obese groups.

**Table 2.** Anthropometric indices and Spirometric parameters

Anthropometric indices	FEV1	P value	FVC	P value	FEV1/FVC	P value
<b>BMI</b>	<20	39.1±20.0 <sup>α</sup>	48.8±21.6		61±7.7	
	20≤ <25	41.2±16.1 <sup>β</sup>	52.5±17.2	0.027	61.5±10.9	0.131
	≥25	52.2±16.4 <sup>αβ</sup>	60.7±14.5		65±6.6	
<b>WC</b>	≤90	41±19.1	51.6±19.8		61.4±9.8	
	>90	50±16.1	58.8±15	0.056	64.3±7.3	0.117
<b>MUAC</b>	≤27	38.3±16.3 <sup>α</sup>	49.6±18.2 <sup>α</sup>		60.5±10.3 <sup>α</sup>	
	27< ≤31.6	45±16.6 <sup>β</sup>	54.7±15.8 <sup>β</sup>	0.003	64.2±8.8 <sup>β</sup>	0.042
	31.6<	56.7±15.9 <sup>αβ</sup>	64.2±14.8 <sup>αβ</sup>		65.8±4.9 <sup>αβ</sup>	
<b>TSFT</b>	≤13	44.9±20.3	54.6±20.3		62.5±8.8	
	13< ≤20	43±15.9	53.5±16.3	0.397	62.8±10.2	0.646
	20<	51±16.7	59.5±15.2		64.5±6.8	
<b>SST</b>	≤15.8	42.3±21.1	52.3±21.4		61.5±9.8	
	15.8<≤24.2	45.7±15.4	56.5±14.8	0.395	63±8.9	0.336
	24.2<	50.6±16.4	58.5±15.5		64.8±6.6	

FEV1: Forced expiratory volume in 1 second, FVC: Forced vital capacity, BMI: Body mass index, WC: Waist circumference, MUAC: Mid-upper arm circumference, TSFT: Triceps skin fold thickness, SST: Subscapular skinfold thickness., α: Represents the difference between 1<sup>st</sup> and 3<sup>rd</sup> groups, β: Represents the difference between 2<sup>nd</sup> and 3<sup>rd</sup> groups

For WC, we classified people as follows (14): 1 for WC≤90cm and 2 for WC>90 cm. As mentioned earlier, there was no correlation in this regard by the Pearson's test, but after classification and applying ANOVA, we found a significant association between WC and FEV1; it was shown that the lower the WC, the lower the FEV1 (P=0.019).

We used tertile to assess MUAC, TSFT and SST. For MUAC, patients were categorized as follows:

1) MUAC ≤ 27 cm, 2) 27 cm <MUAC≤ 31.6 cm and 3) MUAC > 31.6 cm. It was found that the lower the MUAC, the lower the FEV1 (P<0.001). The post-hoc test showed that there were significant differences between the 1<sup>st</sup> and 3<sup>rd</sup> groups, and also between the 2<sup>nd</sup> and 3<sup>rd</sup> groups.

For TSFT, the classification of patients was as follows:

1) TSFT ≤ 13 mm, 2) 13 < TSFT ≤20 mm and 3) TSFT > 20 mm and about the last anthropometric indicator, SST, the patients were categorized as follows:

1) SST ≤ 15.8 mm, 2) 15.8 < SST ≤ 24.2 mm and 3) SST > 24.2 mm.

In spite of all, ANOVA did not find a significant association between FEV1 and TSFT or SST distribution.

Chi-square test was applied for assessing the relationships between anthropometric indicators and dyspnea in COPD patients (Table 3). It was shown that there was an association between MUAC and severity of dyspnea ( $P=0.021$ ).

**Table 3.** Anthropometric indices and clinical respiratory status

Anthropometric indices	Mild	Moderate	Severe	P value	
BMI	<20	2(11.8%)	9(52.9%)	6(53.3%)	0.403
	20≤ <25	5(17.9%)	13(46.4%)	10(35.7%)	
	≥25	14(32.6%)	15(34.9%)	14(32.6%)	
WC	≤90	6(16.2%)	18(48.6%)	13(35.1%)	0.325
	>90	15(29.4%)	19(37.3%)	17(33.3%)	
MUAC	≤27	4(19%)	15(40.5%)	16(53.3%)	0.021
	27< ≤31.6	5(23.8%)	9(24.3%)	10(33.3%)	
	31.6<	12(57.1%)	13(35.1%)	4(13.3%)	
TSFT	≤13	8(38%)	14(37.8%)	8(26.6%)	0.100
	13< ≤20	3(14.2%)	12(32.4%)	15(50%)	
	20<	10(47.6%)	11(29.7%)	7(23.3%)	
SST	≤15.8	7(24.1%)	13(44.8%)	9(31%)	0.388
	15.8<≤24.2	4(13.3%)	13(43.3%)	13(43.3%)	
	24.2<	10(34.5%)	11(37.9%)	8(27.6%)	

BMI: Body mass index, WC: Waist circumference, MUAC: Mid-upper arm circumference,

TSFT: Triceps skin fold thickness, SST: Subscapular skinfold thickness.

## DISCUSSION

COPD is not only a respiratory disease but also a systemic inflammatory condition. Malnutrition and weight loss are the two common problems of COPD patients (15). Causes of weight loss in COPD patients include eating problems (16, 17), high price of ventilation facilities, high metabolic rate (18, 19) and oxidative stress that causes systemic inflammation (20, 21). As stated earlier, anthropometric indicators have been used for assessing nutritional status and muscle dysfunction (5, 6). The greater the malnutrition and weight loss, the greater the disease severity (4, 5).

Our study demonstrated independent relationships between anthropometric indices and spirometric parameters or dyspnea.

In this study, we measured anthropometric indicators namely BMI, WC, MUAC, TSFT and SST.

The study displayed that from 88 patients, 19.3% were underweight, 31.8% were normal weight and 48.8% were overweight/obese. It was shown that underweight patients had lower FEV1; this finding is in accordance with previous studies (6, 13, 22, 23). It means that the higher the BMI, the higher the FEV1. This finding is also in line with the study of Assal and Kamal, since they showed that BMI is positively correlated with FEV1 (24). Also, Mitra et al. demonstrated that as the severity of disease increased, the BMI of patients decreased (25).

The cause and effect relationship illustrating the correlation of BMI and FEV1, is unknown (13). Low BMI may be due to respiratory problems; it is also possible that patients with low BMI experience more severe disease (26).

In contrast to what was mentioned, in some studies, it has been shown that free fat mass index is more sensitive than BMI for estimating disease severity (27, 28); it was said that there is no correlation between BMI and FEV1 or FEV1/FVC (28). These controversies may be due to patients' underlying conditions (6).

We did not find any relationship between BMI and dyspnea. In some studies, underweight patients had higher frequency of exacerbations (13, 29, 30). In several studies, BMI was proven to be a predictor of mortality; underweight patients had higher mortality rate (4, 5, 13). It was shown that overweight COPD patients had lower mortality (13, 22, 23, 31); however, midhigh muscle cross-sectional area (30) and mid-arm muscle area (10) are indicated to be better predictors of mortality in these patients. Moreover, some researchers found a relationship between decreased muscle mass and mortality, independent of reduction in FEV1 (32).

In our study, the prevalence of abdominal obesity ( $WC>90\text{cm}$ ) was 57.9%. The patients who had lower WC ( $\leq 90\text{cm}$ ) had lower means of FEV1. We did not find a significant association between WC and dyspnea. In a previous study, WC was used, like MUAC, as an anthropometric indicator for evaluation of malnutrition; but they did not report a significant association between WC and FEV1 or other parameters (5).

About MUAC, our study confirmed that there was a relationship between MUAC and FEV1. The lower the MUAC, the lower the FEV1. Also, MUAC had an association with dyspnea. However, according to Table 3, there was no definite increasing or decreasing trend for frequencies in MUAC grouping by dyspnea, and this was probably due to the small number of patients. In previous studies, MUAC was used for assessing nutritional status (5, 29); however, we did not find any study to show the relationship between MUAC and FEV1 or dyspnea, directly.

Another anthropometric indicator that we assessed in our study was TSFT. There was no relationship between TSFT and FEV1 or dyspnea. Usually, in the recent studies, TSFT was evaluated besides MUAC as a nutritional status indicator (5). Also, a previous study reported that MUAC, TSFT and MAMC were significantly lower in COPD patients with malnutrition (29).

The last anthropometric indicator evaluated was SST. We found that, there was no correlation between SST and spirometric parameters or dyspnea. To the best of authors' knowledge, there has been no study on SST in COPD patients.

Anthropometric indices can be used to predict malnutrition (5). What is important about nutritional status in these patients is that malnutrition is treatable and this has been emphasised in COPD management recommendations (33). There are potential benefits in improving nutritional status, including resolving symptoms and improving the prognosis of disease (4).

One limitation of our study was that evaluation of dyspnea in our study depended on patients, and they might have had difficulty in estimating its severity.

Also, we only had five female patients; thus, we could not compare the parameters between men and women. Further studies are recommended in this regard on both sexes.

Moreover, further studies are required to evaluate anthropometric indices; for example, in terms of the association of MUAC and dyspnea, we did not find a

definite increasing or decreasing trend, probably because of the small number of patients in our study. Thus, more studies on larger sample sizes are required to evaluate these factors. Furthermore, since no study was found on SST in COPD patients, further studies need to be done in order to reach a definite conclusion with regard to this indicator.

## CONCLUSION

This study examined antropometric indicators in COPD patients and their association with spirometric parameters and dyspnea. It was shown that FEV1 was associated with BMI, WC and MUAC, and MUAC was associated with dyspnea. We did not find any association between these parameters and TSFT or SST.

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