# WAIST CIRCUMFERENCE DOES NOT CORRELATE WITH FUNCTIONAL LUNG CAPACITY IN MODERATE AND SEVERE CHRONIC OBSTRUCTIVE PULMONARY DISEASE

Sanja Popović-Grle[1,3], Agata Ladić[2], Bojana Butorac-Petanjek[3], Jasna Špiček-Macan[3] and Branka Čučević[3]

[1]School of Medicine, University of Zagreb; [2]Clinical Department of Gastroenterology and Hepatology, Zagreb University Hospital Center; [3]Jordanovac Clinical Department for Lung Diseases, Zagreb University Hospital Center, Zagreb, Croatia

SUMMARY – Waist circumference is a good predictor of the risk of heart diseases, but data on the relationship between waist circumference and pulmonary diseases are sparse. The aim of this study was to investigate its influence on pulmonary function regarding exercise capacity in moderate and severe chronic obstructive pulmonary disease (COPD), according to Global Initiative for Lung Diseases (GOLD) stages. During 2009, a total of 70 COPD patients aged 33 to 80 years were stratified into GOLD 2 and GOLD 3 stages. Diagnostic separation between COPD severity groups was made upon percentage of predicted forced expiratory volume in 1 second. Anthropometric measures, lung function testing and prognostic scoring systems were assessed. Logistic regression analysis was used to make comparisons while taking into account the possible confounding factors. Waist circumference did not show substantial variations between GOLD 2 and GOLD 3 stages (p>0.5). There was a weak positive correlation between waist circumference and percent of predicted 6-minute walking distance (r=0.237; p=0.001). Another parameter, suprailiac skinfold, was significantly different between GOLD 2 and GOLD 3 stages (19.41 *vs.* 15.32 mm; p=0.047). Although waist circumference is a meaningful marker of abdominal obesity, which influences pulmonary function, we failed to prove its importance in correlation with functional lung capacity in a selected COPD population. However, suprailiac skinfold deserves greater attention and further evaluation.

Key words: *Chronic obstructive pulmonary disease; Global Initiative for Lung Diseases (GOLD) stages; Waist circumference; Six-minute walking distance; Spirometry*

## Introduction

Chronic obstructive pulmonary disease (COPD) is among the most common diseases encountered in general practitioner office. Due to its progressive nature and heavy social burden, the experts believe it will be on the third place of all-death causes by 2030[1]. Today, we know that COPD is not only pulmonary disease, but also a disease that affects many organs and tissues. Numerous inflammatory mediators, as well as oxidative stress yield loss of body weight, muscle mass, tissue depletion, lowered exercise capacity[2], ischemic heart disease, osteoporosis, normocytic anemia, lung carcinoma, depression, and diabetes mellitus[3]. It is still debated whether 'spilling out' of inflammatory mediators in the circulation and associated inflammatory reaction are the main reasons for the disease development, or tobacco smoke is the main culprit which affects not only lungs but also other systems and organs[4,5].

Correspondence to: *Asst. Prof. Sanja Popović-Grle, MD, PhD*, Jordanovac Clinical Department for Lung Diseases, Zagreb University Hospital Center, Jordanovac 104, HR-10000 Zagreb, Croatia
E-mail: sanja.grle@kbc-zagreb.hr

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A growing body of literature explains that body composition gravely affects lung function[6]. In order to predict disease severity and functional limitations, certain anthropometric measures could be highly valuable and appreciated, especially owing to the fact that they are easily obtained and financially undemanding. One of them, which we observed in this study, is waist circumference (WC). Waist circumference is only one of a few anthropometric measures that predict abdominal obesity[7], with sex as the main influencing factor. From previous studies we know that in male population there is a tendency of acquiring fat tissue around waist, while female population with aging acquires fat tissue mostly on hips, gluteal regions and upper legs. Men who have WC higher than 102 cm and women over 88 cm are prone to develop certain complications[8]. Enlarged WC and obesity are influencing factors in many chronic diseases, such as adult diabetes mellitus, arterial hypertension, stroke and heart attack.

A great number of studies on the correlation of WC and coronary artery disease (CAD) have already been performed; however, there are no studies correlating abdominal obesity (presented with WC) and functional limitations in COPD, which was the reason to conduct this study.

## Study Design and Methods

### *Subjects*

The study included 70 outpatients of both sexes aged 33 to 80 years, with a history of COPD, stratified into moderate and severe groups according to the Global Initiative for Lung Diseases (GOLD) classification[9]. Diagnostic separation between COPD severity groups was made upon percentage of forced expiratory volume in the first second ($FEV_1$) of the predicted value for each subject ($FEV_1$= 30%-80% of reference value, $FEV_1$/FVC <70%), with a negative salbutamol test (<12% or 200 mL of $FEV_1$ improvement after salbutamol inhalation *via* a meter-dosed inhaler (MDI)). The inclusion criterion was also the status of current or ex-smoker, with a pack-years ratio ≥10. The exclusion criteria were absence of clinically significant chest x-ray abnormalities, malignant disease, severe gastrointestinal or hepatic disease, significant renal, rheumatologic, neurologic or endocrine disease, serious mental disorders, clinically significant acute illness, or surgery within previous 4 weeks.

All patients were receiving some of the usual COPD medications, i.e. anticholinergics (ipratropium or tiotropium), theophylline, short- or long-acting $beta_2$-agonists (SABA or LABA, salbutamol or salmeterol); a few of those having $FEV_1$ under 50% of the predicted value were also taking inhalation corticosteroids (budesonide or fluticasone), mostly in combination with LABA. Patients were under therapy for their concomitant diseases, most often antihypertensives and oral hypoglycemics.

For the assessment of comorbid conditions, patients were asked whether they had or had had any of the following diseases: myocardial infarction, diabetes mellitus or arterial hypertension; their medical history data were carefully examined.

All subjects were interviewed by the 'doctor-to-patient' method and examined by an experienced pulmonologist at Outpatient Department, Jordanovac Clinical Department for Lung Diseases, Zagreb University Hospital Center, Zagreb, Croatia. Patients were examined during the stable phase of COPD, from January to December 2009.

The Medical Research Council (MRC) dyspnea scale was performed according to the GOLD Executive Committee modified MRC scale[10]. COPD patients were classified as MRC 0, if they did not have any breathlessness at all. If they felt dyspnea on any occasion, they had MRC scale as follows: MRC 1 scale if they had shortness of breath when walking up a slight hill; MRC 2 if walked slower than people of the same age on the level ground due to breathlessness; MRC 3 if stopped for breath after walking about 100 m or after a few minutes on the level ground; and MRC 4 if they were too breathless to leave the house or breathless when dressing.

Written informed consent for participation in the study was obtained from each patient. The study was performed in compliance with the Good Clinical Practice. The study protocol and informed consent form were reviewed and approved by the Ethics Committee of the Jordanovac Clinical Department for Lung Diseases.

### *Methods*

Eligible patients underwent detailed anthropometric measurements, lung function tests and exercise test (6-minute walk distance)[11]. Anthropometric measurements included age, height, weight, body mass index (BMI), fat free mass index (FFMI), WC, abdominal skinfold (SFa), suprailiac skinfold (SFs) and waist-hip distance (WHD). Lung function tests included: (a) spirometry with FVC, $FEV_1$, Tiffeneau's index ($FEV_1$/FVCx100); (b) blood gas analysis with acid-base status and oxygen saturation before exercise testing ($SaO_2$) and after testing; and (c) pulmonary diffusion with DLCO and transfer coefficient (KCO). Lung function testing was performed in the following order: blood gas analysis, spirometry, diffusing capacity and finally bronchodilator response to salbutamol. Salbutamol test was considered negative if $FEV_1$ improvement 15-30 minutes after the nurse had administered 400 mcg of salbutamol *via* an MDI without spacer was <12% or 200 mL. The 6-minute walk distance was done on the next morning, according to the standard procedure, without verbal encouragement by the staff[12].

Additionally, two widely used prognostic multigrading systems for disease severity, BODE and ADO indices[13,14] were used, as well as MRC dyspnea scale[15].

All lung function tests were done in the morning from 9.00 to 12.00 a.m. on a MasterLab, E. Jaeger (Germany), version 3.0. Spirometry was repeated at least three times, mostly eight times, until two reproducible efforts were obtained. The exhalation effort had to be at least 6 seconds, or until the end-expiratory plateau was reached. The two largest FVC and $FEV_1$ values had to show less than 5% variability, according to the standardized procedure[16]. Predicted values were the most commonly used ECCS values[17]. Pulmonary diffusing capacity was measured by the single-breath method with carbon monoxide, on MasterScreen Diffusion, E. Jaeger (Germany)[18].

### *Ethics statement*

The study was approved by the Ethics Committee, Jordanovac Clinical Department for Lung Diseases, Zagreb, Croatia as of November 19, 2009, and performed in accordance with the Declaration of Helsinki. The informed written consent was obtained from all study participants.

### *Statistical analysis*

Data were analyzed using the Statistica version 6.0 statistical software (StatSoft, Inc., Tulsa, OK, USA). Descriptive statistics was used for basic characteristics and variables of subgroups. The overall frequency distribution of most of the variables was normal and the mean and standard deviation were used in data description. Student's t-test was used to evaluate significant difference in the means, comparisons between categorical variables were performed using the $\chi^2$-test or Fisher exact test, and logistic regression analysis was used to make comparisons while taking into account the possible confounding factors. A p-value <0.05 was taken as statistically significant for all analyses.

## Results

### *Characteristics of study participants*

A total of 70 COPD patients were stratified into two groups, GOLD 2 stage (moderate disease) and GOLD 3 stage (severe disease), comparable in all anthropometric variables (Table 1). Thirty-eight (54.3%) patients were in GOLD 2 stage and 32 (45.7%) in GOLD 3 stage. Male patients were predominant in both groups, with the mean age (±SD) of 64.5±7.8 years in GOLD 2 group and 63.9±10.7 years in GOLD 3 group. There was no statistically significant difference in WC in either sex (p>0.5 both) between GOLD 2 and GOLD 3 stages. The suprailiac skinfold differed statistically significantly between GOLD 2 and GOLD 3 stages (19.41 vs. 15.32 mm; p=0.047) (Table 1).

### *Lung function testing across moderate and severe stages*

According to the classification criteria, respiratory function parameters significantly differed between GOLD 2 and GOLD 3 stages (FVC and $FEV_1$: p<0.001 both; and 6-MWD measured in meters: p<0.05). However, there was no significant variation for 6-MWD% of the predicted value (p=0.360) (details in Table 2).

### *Multigrading system scores*

Both prognostically important multigrading score systems, found lately in the COPD scientific literature, BODE and ADO, showed a statistically significant difference across the GOLD stages (p<0.001 both) (Table 3).

*Table 1. Anthropometric measures according to GOLD 2 and GOLD 3 stages*

| | GOLD 2 N=38 | GOLD 3 N=32 | t-value | p-value |
|---|---|---|---|---|
| Age (yrs) | 64.52 (7.83) | 63.90 (10.72) | 0.279 | 0.781 |
| Height (cm) | 171.21 (9.40) | 169.96 (11.22) | 0.504 | 0.616 |
| Weight (kg) | 79.86 (11.87) | 74.06 (16.89) | 1.634 | 0.108 |
| BMI (kg/m$^2$) | 27.24 (3.43) | 25.43 (4.70) | 1.858 | 0.068 |
| FFMI | 28.72 (7.83) | 26.35 (8.64) | 1.200 | 0.234 |
| **WC (cm)** | **98.87 (11.66)** | **95.66 (13.42)** | **1.072** | **0.288** |
| M | 102.35 (10.67) | 99.84 (10.56) | 0.800 | 0.427 |
| F | 92.89 (11.14) | 86.45 (14.93) | 1.212 | 0.238 |
| **SFs (mm)** | **19.41 (9.69)** | **15.32 (6.57)** | **2.025** | **0.047** |
| SFa (mm) | 18.98 (10.93) | 16.56 (7.36) | 1.063 | 0.291 |
| WHD(mm) | 17.26 (4.08) | 16 (3.18) | 1.424 | 0.159 |

All values are expressed as mean ± SD; BMI = body mass index; FFMI = fat free mass index; WC = waist circumference; M = male; F = female; SFs = suprailiac skin fold; SFa = abdominal skin fold; WHD = waist-hip distance

### *Association of 6-MWD (%) with anthropometric measurements and lung function*

Statistically significant predictors for 6MWD% were ADO index, FFMI, WHD, KCO, height, FVC (%), MRC scale, BMI, BODE index and $FEV_1$ (%), with adjusted r square 0.647, $F_{10,59}=13.638$, $p<0.001$ (Table 4).

### *Association of 6-MWD (m) with anthropometric measurements and lung function*

The 6-MWD measured in meters yielded a slightly different model for the best prediction. This analysis identified age, $FEV_1$ (%), FFMI, waist-hip distance, MRC scale and BODE index as significant predictors, adjusted r square 0.718; $F_{6,63}=30.244$; $p<0.001$ (Table 5).

*Table 2. Lung function testing according to GOLD 2 and GOLD 3 stages*

| | GOLD 2 N=38 | GOLD 3 N=32 | t-value | p-value |
|---|---|---|---|---|
| FVC_A (L) | 2.97 (0.78) | 2.47 (0.76) | 2.720 | 0.008 |
| FVC (%) | 83.28 (11.25) | 68.88 (11.85) | 5.205 | 0.000 |
| $FEV_1$_A (L) | 1.81 (0.50) | 1.16 (0.33) | 6.287 | 0.000 |
| $FEV_1$ (%) | 63.19 (7.65) | 41.10 (6.47) | 12.903 | 0.000 |
| Tiffeneau index | 57.97 (7.09) | 44.83 (7.64) | 7.455 | 0.000 |
| DLCO (%) | 72.58 (19.55) | 60.69 (19.71) | 2.526 | 0.014 |
| KCO | 79.87 (21.48) | 69.85 (21.49) | 1.943 | 0.056 |
| 6-MWD (m) | 383.89 (84.53) | 338.09 (81.50) | 2.296 | 0.025 |
| 6-MWD (%) | 73.58 (13.55) | 62.83 (12.87) | -0.291 | 0.360 |
| $SaO_2$rest (%) | 95.5 (1.94) | 94.94 (1.44) | 1.356 | 0.180 |
| $SaO_2$exercise (%) | 94.05 (3.22) | 92.47 (3.18) | 2.061 | 0.043 |

All values are expressed as mean ± SD; FVC_A = forced vital capacity, expressed in absolute number in litres; FVC (%) = forced vital capacity expressed in percentage of the predictive value; $FEV_1$_A = forced expiratory volume in first second, expressed in absolute number in litres; $FEV_1$% = forced expiratory volume in the first second, expressed in percentage of the predicted value; DLCO = diffusing capacity for carbon monoxide; KCO= transfer coefficient; 6-MWD (m) = 6-minute walking distance measured in meters; 6-MWD (%) = 6-minute walking test in percentage of the predictive value; $SaO_2$rest = oxygen saturation before pulmonary function testing; $SaO_2$exercize = oxygen saturation after 6-MWT.

*Table 3. Multigrading system score distribution according to GOLD 2 and GOLD 3 stages*

| | GOLD 2 N=38 | GOLD 3 N=32 | t-value | p-value |
|---|---|---|---|---|
| MRC scale | 1.34 (0.534) | 1.72 (0.581) | -2.823 | 0.006 |
| BODE index | 2.37 (1.172) | 4.91 (1.146) | -9.115 | 0.000 |
| ADO index | 3.82 (1.270) | 5.03 (0.933) | -4.605 | 0.000 |

MRC scale = Medical Research Council Dyspnea scale; BODE index = Body Mass Index, Obstruction, Dyspnea, Exercise capacity; ADO index = Age, Dyspnea, Obstruction.

*Sex*

When we finally introduced sex as a predictive variable, next to lung function testing values and anthropometric measurements, the best model was one with waist-hip distance, age, MRC scale, FFMI, BODE index and $FEV_1$% as significant variables with adjusted r square 0.718, $F_{6,63}$=30.244, p<0.001 (Table 6).

## Discussion

This analysis was designed to show the possible correlation between WC and functional capacity in COPD. Our results showed that WC was not significantly related to exercise capacity in these patients.

A large epidemiological research was conducted in Paris including 121,965 healthy subjects, which showed that abdominal obesity, among all other entities of metabolic syndrome, was a key factor for lung function impairment[19]. A Canadian study in 1647 healthy subjects showed WC to correlate highly with reduction in FVC and FEV in the first second[20]. We found a weak, nonsignificant negative linear correlation between WC and FVC (r=-0.186; p=0.061) and positive correlation with $FEV_1$ (r=0.132; p=0.137).

Our results on the correlation of WC, anthropometric measures and lung function tests differ from those reported from the above mentioned large epide-

*Table 4. Association between 6-MWD (%), lung function tests and anthropometric measures*

| | 6-MWD (%) | | |
|---|---|---|---|
| | B | SE | P |
| Height | -0.325 | 0.125 | <0.001 |
| FVC (%) | 0.238 | 0.118 | 0.038 |
| $FEV_1$ (%) | - 0.786 | 0.163 | <0.001 |
| KCO | 0.175 | 0.060 | 0.065 |
| BMI | 0.286 | 0.411 | 0.020 |
| FFMI | -0.317 | 0.196 | 0.007 |
| Waist-hip | 0.126 | 0.284 | 0.096 |
| MRC scale | 0.291 | 2.587 | 0.008 |
| BODE index | -1.480 | 1.578 | <0.001 |
| ADO index | 0.316 | 1.210 | <0.005 |

β = regression coefficient for each predictor variable; SE = standard error

Multivariate multiple regression analysis. 6-MWD (%) = 6-minute walking test in percentage of the predictive value FVC (%) = forced vital capacity expressed in percentage of the predictive value; $FEV_1$% = forced expiratory volume in the first second, expressed in percentage of the predicted value; KCO= transfer coefficient;

BMI = body mass index; FFMI = fat free mass index; MRC scale = Medical Research Council Dyspnea scale; BODE index = Body Mass Index, Obstruction, Dyspnea, Exercise capacity; ADO index = Age, Dyspnea, Obstruction.

*Table 5. Association between 6-MWD measured in meters, pulmonary function tests and anthropometric measures*

| | 6-MWD (m) | | |
|---|---|---|---|
| | B | SE | p |
| Age | -0.171 | 0.653 | 0.018 |
| $FEV_1$ (%) | -0.737 | 0.795 | <0.001 |
| FFMI | -0.330 | 0.687 | <0.001 |
| Waist-hip | 0.126 | 0.284 | 0.096 |
| MRC scale | 0.291 | 2.587 | 0.008 |
| BODE index | -1.480 | 1.578 | <0.001 |
| ADO index | 0.316 | 1.210 | <0.005 |

β = regression coefficient for each predictor variable, SE =standard error

Multivariate multiple regression analysis. 6-MWD (m) = 6-minute walking distance measured in meters; $FEV_1$% = forced expiratory volume in the first second, expressed in percentage of the predicted value; FFMI = fat free mass index; MRC scale = Medical Research Council Dyspnea scale; BODE index = Body Mass Index, Obstruction, Dyspnea, Exercise capacity; ADO index = Age, Dyspnea, Obstruction.

*Table 6. Association between 6-MWD measured in meters, pulmonary function tests and anthropometric measures including sex*

| | 6-MWD (m) | | |
|---|---|---|---|
| | β | SE | p |
| Age | -0.171 | 0.653 | 0.018 |
| $FEV_1$ (%) | -0.737 | 0.795 | <0.001 |
| FFMI | -0.330 | 0.687 | <0.001 |
| Waist-hip | 0.125 | 1.520 | 0.063 |
| MRC scale | 0.329 | 13.893 | <0.001 |
| BODE index | -1.393 | 7.452 | <0.001 |

β = regression coefficient for each predictor variable, SE = standard error

Multivariate multiple regression analysis. 6-MWD (m) = 6-minute walking distance measured in meters; $FEV_1$% = forced expiratory volume in the first second, expressed in percentage of the predicted value; FFMI = fat free mass index; MRC scale = Medical Research Council Dyspnea scale; BODE index = Body Mass Index, Obstruction, Dyspnea, Exercise capacity.

miological studies in healthy subjects. We found that FVC and $FEV_1$ correlated negatively with WC; however, the correlation was weak and statistically nonsignificant (WC/FVC r=-0.186, p=0.061; WC/$FEV_1$ r=0.132, p=0.137). The correlation of BMI and lung function tests was also statistically nonsignificant.

Considering COPD severity, discussion is going on among scientists because we are aware that none of the known parameters alone is sufficient to determine exactly the severity as well as the risk of mortality. We established COPD severity grade according to the percentage of $FEV_1$ value, as recommended by the GOLD guidelines[17]. Large investigations are in progress (such as ECLIPSE study)[21], trying to define the most predictive parameter when observing COPD severity.

Chronic obstructive pulmonary disease is a summation effect of more than one factor. As already mentioned, the main culprit is tobacco smoke which generates oxidative stress, changes signal pathways[22] and enzyme activities[23], alters a number of inflammatory mediators[24], influences the glutathione cycle[25], elevates acute phase proteins and affects selective loss of 'fat-free mass', which alters respiratory and peripheral muscle function and results in functional capacity and exercise capacity reduction[2].

Physical inactivity is associated with higher GOLD stage, independently of BMI[26]. It may possibly be due to low grade inflammation that contributes to worsening of COPD. According to Serres *et al.*, physical inactivity is a result of so-called dyspnea spiral, where patients choose sedentary life in order to avoid dyspnea[27]. Furthermore, adipose tissue can act as an additional source of inflammatory mediators[28]. A Japanese study revealed that visceral fat area was significantly higher in COPD patients, especially in advanced COPD stages[29], despite the absence of obesity. It is somehow inconsistent, as we expect that a person who is physically inactive and leads a sedentary life is prone to obesity. Eventually, there is a cut-off point at which inactivity leads to lessening of appetite, but most likely here we come to the hormonal point, and possible 'leptin and adiponectin balance', which was not investigated in the present study.

Why combining WC and COPD? Now we know that CAD and abdominal obesity are highly correlated, as well as that those current smokers who have enlarged WC bear the highest risk of acquiring heart disease[30]. When considering BMI and WC, studies demonstrated that WC was associated with incident chronic heart failure, but not BMI. Further on, abdominal fat tissue is possibly a stronger risk factor for heart failure than overall obesity[31]. In a Polish study, the ratio between waist and square height had the advantage over BMI and waist/height ratio or WC concerning predictive value for CAD[32]. In terms of exercise capacity and GOLD severity stages, we found a slightly stronger correlation between BMI and 6MWD% than between WC and 6MWD% (r=0.351, p=0.001 *vs.* r=0.237, p=0.024).

### *Waist circumference and 6-minute walk distance*

The 6-minute walk distance (6-MWD) is a useful test which provides information on functional lung capacity. Having in mind that across different stages of GOLD we have lessened or enlarged functional capacity, we took 6-MWD as the main differentiating factor between GOLD 2 and GOLD 3 stages. Among all investigated parameters, our regression model results showed that height, FVC (%), $FEV_1$ (%), BMI, FFMI, WHD, MRC scale, BODE and ADO indices combined explained the major variability between GOLD 2 and 3 stages. So far, we know that a distance less than 350 meters is associated with increased mortality in chronic obstructive disease and chronic heart failure[33]. In our GOLD 2 stage, the mean distance was 383 meters and in GOLD 3 stage 338 meters. Mortality rate was not assessed in this study, but we see that with disease progression, there is a trend towards lowered functional capacity. In a Canadian study in 21 obese and overweight but otherwise healthy individuals, walking distance negatively correlated with BMI and WC[34]. We found a positive relationship between BMI and 6-MWD ($r=0.351$, $p<0.001$), possibly due to the higher number of patients than in the above mentioned Canadian study. In our study, WC also showed a positive but weak association with 6-MWD% ($r=0.237$, $p=0.024$). Thus, we failed to prove the same effect as was seen in the Canadian population, realizing that healthy and sick individuals differ in pulmonary function tests.

### *Waist circumference and sex*

We have already mentioned that the main influencing factor on WC is sex[8]. The recommendations accepted in our country consider WC >94 cm in men and >80 cm in women pathologic[35]. According to these figures, our male and female patients had pathologic WC (male 101.15±10.57 cm and female 90.20±12.96 cm), but in regression analysis sex did not enter the final regression model, meaning that it is not one of the main influencing factors (Table 6).

### *Waist circumference and age*

Knowing that COPD can increase the change in body composition that is normal with aging[36-38], we can assume that owing to the minimal difference in the mean age of our study population (64.52 *vs.* 63.90 years), we did not find strong relationship of WC and lung function according to age.

### *Skinfolds and COPD severity*

Malnutrition is one of the several risk factors that lead to poorer prognosis in COPD patients. It has been proved that it increases dyspnea severity and reduces exercise tolerance[39]. There are a few studies correlating different skinfolds (mostly subscapular and triceps) with COPD severity. According to Marquiz *et al.*, midthigh cross-sectional area is a better predictor of mortality than BMI in COPD patients[1]. Besides WC, we introduced abdominal and suprailiac skinfold. According to t-test, a significant difference between GOLD 2 and GOLD 3 stages was found for suprailiac skin fold (19.41 *vs.* 15.32mm, $p=0.047$), raising a question whether suprailiac skinfold should be measured on each patient visit.

### *Limitations of our study*

The number of our patients was quite small, which could have biased final results. Another possible disadvantage is that we did not include patients in GOLD 1 and GOLD 4 stages. Our study was clinical, not epidemiological study; therefore, it was not likely to find a large number of patients in GOLD 1 stage, as is expected when screening scheme includes young smokers. Patients who have GOLD 1 stage rarely come to the hospital, while patients who are in GOLD 4 stage sometimes are not capable of doing exercise test, 6-MWD. However, the advantage of our sample was performance of complete pulmonary function testing in resting position and during exercise, as well as thoroughly examined anthropometric measurements.

## Conclusions

Waist circumference is an easily obtainable parameter that failed to prove significance in determining correlation with COPD severity stages and lower exercise capacity in our COPD patients. However, another parameter, suprailiac skinfold, deserves greater attention and future evaluation in assessing COPD patients. Another important finding is that WC and BMI act differently in healthy subjects and COPD patients; therefore, future investigation in a larger COPD population is needed.

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Sažetak

## OPSEG STRUKA NE KORELIRA S FUNKCIONALNOM PLUĆNOM SPOSOBNOSTI KOD UMJERENE I TEŠKE KRONIČNE OPSTRUKTIVNE PLUĆNE BOLESTI

*S. Popović-Grle, A. Ladić, B. Butorac-Petanjek, J. Špiček-Macan* i *B. Čučević*

Povećani je opseg struka dobar predskazatelj rizika za razvoj srčanih bolesti, no gotovo da nema podataka o odnosu opsega struka i plućnih bolesti. Cilj ove studije bio je ispitati utjecaj veličine opsega struka na funkcionalnu plućnu sposobnost prema klasifikaciji GOLD (Global Initiative for Lung Diseases). Tijekom 2009. godine 70 bolesnika u dobi od 33 do 80 godina podijeljeno je u skupine GOLD2 i GOLD3 ovisno o težini bolesti. Dijagnostička razdioba ovih skupina temelji se na razlici dobivenih vrijednosti predviđenog forsiranog ekspiracijskog volumena u prvoj sekundi. Analizirane su brojne antropometrijske mjere, testovi plućne funkcije i prognostički bodovni sustavi. U statističkoj je obradi korištena logistička regresijska analiza. Razlika u veličini opsega struka između stupnjeva GOLD2 i GOLD3 nije dosegla statističku značajnost (p>0,5). Nađena je slaba pozitivna korelacija između opsega struka i postotka predviđene udaljenosti u 6-minutnom hodu (r=0,237; p=0,001). No, statistički značajna razlika između dviju ispitivanih skupina nađena je u debljini suprailijačnog nabora (19,41 prema 15,32 mm; p=0,047). Opseg struka je jedan od parametara koji definiraju abdominalnu pretilost. Iako pretilost utječe na plućnu funkciju, ova studija nije dokazala da postoji korelacija između veličine opsega struka i funkcionalne plućne sposobnosti u odabranoj populaciji bolesnika s kroničnom plućnom bolešću. No, daljnju evaluaciju i vrednovanje u kliničkoj praksi zaslužuje mjerenje suprailijačnog nabora.

Ključne riječi: *Kronična opstruktivna plućna bolest; Stupnjevi GOLD; Opseg struka; Šest-minutni test hoda; Spirometrija*