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INFLUENCE OF OBESITY ON SPIROMETRIC PARAMETERS IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Harmful air particles emissions (heavy industry, thermal and nuclear power plants, vehicles that burn fissile fuel, professional exposure in factories and mines, consumption of cigarettes), greatly disturb the function of the respiratory system. Obesity is associated with chronic low-grade inflammation and increased numbers of activated macrophages in adipose tissue. Adipose tissue provides an abundance of inflammatory mediators, suggesting a possible link between obesity and immunological developments in COPD.

The aim of the paper was to determine whether obesity has a significant effect on spirometric parameters in patients with COPD, and to determine whether weight loss caused by reduction of adipose tissue has a positive effect on improvement of spirometric parameters in patients with COPD.

The study included 190 examinees aged 35 to 65 years, of both sexes, divided into four groups: the first group recruited 40 examinees with different degrees of obesity and without verified COPD, 20 persons (group 1a) with obesity from I (BMI 30-35) to III (BMI>40) and 20 subjects (group 1b) with pre-obesity (BMI 25-30); the second group included 50 examinees who had normal nutritional status and COPD with different duration; the third group consisted of 50 examinees, who had I degree obesity (BMI 30-35) and COPD; the fourth group consisted of 50 examinees, who had II degree obesity (BMI of 35-40) and COPD with different duration.

The research lasted three years, covering the period from 2007 to 2010. The subjects were being examineed for 180 days, and all the changes related to spirometry parameters and body mass index (BMI) were followed up.

Comparing the average measures and standard deviations in FEV1/ FVC between groups 4 (66,71±4,53), 2 (69,1±5,98) and 3 (70,69±5,81), there were no significant statistical differences. The values of spirometric parameters between two groups of patients with COPD were compared. The first group of patients involved subjects who in the period of 180 days had weight loss greater than 10% and second (2) group in which subjects had no significant weight loss. It was found that respondents from the first group had a statistically significant increase in the observed values of all spirometric parameters compared to another group. FVC: 4.33(1) 0.99(2); p<0, 01. FEV1: 7.38(1) 2.67(2); p<0.01. FEV1/FVC: 4,27(1) 2,14(2); p<0,05.

Obesity has no significant effect on spirometric parameters in patients with COPD. Losing weight in favor of adipose tissue reducing has a significant effect on improving the spirometric parameters in patients with COPD. *Acta Medica Medianae 2011; 50(4): 11-16.*

Key words: *obesity, influence, chronic obstructive pulmonary disease (COPD), spirometric parameters, Body Mass Index (BMI)*

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Introduction

Harmful air particles emissions (heavy industry, thermal and nuclear power plants, vehicles that burn fissile fuel, professional exposure in factories and mines, consumption of cigarettes), greatly disturb the function of the respiratory system. It simply gives any individual the right to ask whether there is a relationship between obesity and quality of breathing. We know that in some patients who have body mass index-BMI over 40, almost half of their body weight belongs to the adipose tissue (1). Two principal mechanical effects of obesity on respiratory lung function have been identified: an adipose tissue and muscle weakness. Analyzing the fat thickness (expressed in length), the visualization and measurement of which were enabled by applying this method, we found out that higher values of thickness are correlated with a higher degree of reduction in amplitude of the oscillation frequency and acceleration during the respiratory cycle in identical conditions. It was observed that especially

higher values of abdominal fat have a significant effect on the above relationship (2) .

The weakness of respiratory muscles in obese individuals is attributed to muscle inefficiency. It is the result of reduced ability of the chest wall muscles (during the process of muscle contractions), which are surrounded by a layer of adipose tissue, reduced diaphragm movements, the primary muscle involved in the breathing action. On the other hand, the necessary circulation which delivers oxygen and nutrients for normal muscle functioning is compromised to some extent by different redistribution in obese people, causing all the muscles in general to suffer. This is supported by the fact that breathing exercises are used to enhance the lung capacity which is often weakened (of reduced intensity) in obese patients compared to examinees with normal body weight (3).

Obesity is associated with chronic low-grade inflammation and increased number of active macrophages in the adipose tissue. Adipose tissue provides an abundance of inflammatory mediators, suggesting a possible link between obesity and immunological developments in COPD. This hypothesis is explained by histological preparations of adipose tissue on more than 10,000 samples, where the immune cytological analysis evidenced high number of macrophages in the connective tissue between the adipocytes. The presence of increased concentrations of C-reactive protein, tumor necrosis factor alpha (TNF-α) and interleukin-6 in the serum of the obese population has been undoubtedly proved (4) .

TNF-α is a proinflammatory cytokine which is mainly secreted by macrophages. It plays a role in the regulation of a wide range of biological processes, including cell proliferation, differentiation and apoptosis, which have physiological basis, particularly in modulation of mucous tissues in the respiratory tract, which is the main pathological feature of COPD.

Reduction diets (reduced food intake) are definitely the optimal health strategies for the obese patients with chronic respiratory disease. Several studies have shown that therapeutic approaches, principles and maintaining of weight loss included food reduction, increase in physical activity and medical care (absorption of fats from digestive tract), whereby, in short time, a moderate degree of reduction in weight or fat tissue has been achieved. However, long-term investigation studies' results have shown the opposite, because the majority of patients have succeeded to regain some or most of their weight (5).

There are no specific recommendations about weight loss, or appropriate strategies on regulation of body weight in patients with chronic respiratory diseases. This poses a problem, because patients with chronic respiratory diseases are often inactive, and therefore are often not able to comply with the recommendations related to the level of physical activity.

Aim

- To determine whether obesity has a significant effect on spirometric parameters in patients with COPD.
- To determine whether weight loss caused by reduction of adipose tissue has a positive effect on improvement of spirometric parameters in patients with COPD.

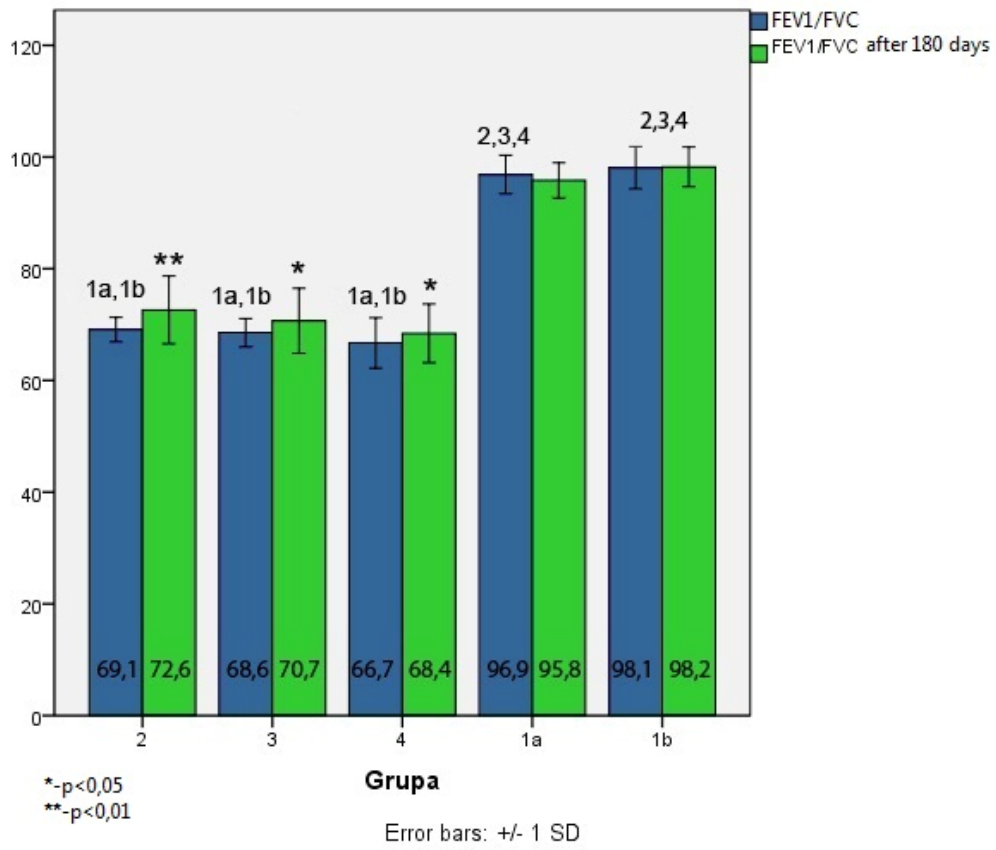
Patients and methods

The study included 190 examinees aged from 35 to 65 years old, of both sexes, divided into four groups.

1. The first group (1a) consisted of 40 examinees with different degrees of obesity and without verified COPD, 20 individuals (group 1a) with obesity from I (BMI 30-35) to III (BMI> 40) and 20 individuals (group 1b) with pre-obesity (BMI 25-30).
2. The second group consisted of 50 examinees of different age structure, both sexes, who have normal nutritional status and COPD with different duration.
3. The third group consisted of 50 examinees of different age structure, both sexes, who had obesity degree (BMI 30-35) and COPD with different duration and degree severity.
4. The fourth group consisted of 50 examinees of different age structure, both sexes, who had II degree obesity (BMI of 35-40) and COPD of different duration and severity degree.

The research period lasted three years, from 2007 to 2010. Patients who fulfilled basic conditions for participation in the study underwent the clinical examination which included the important measurements of body weight, body height and calculation of BMI using the formula BMI=TT/TV2, as well as the waist measurements, on the basis of which the examinees were selected in groups according to degree obesity and obesity classification (WHO, 1997). The subjects were followed up for 180 days and spent 15 days both at the beginning and end of the study in the home institution Special Hospital "Sokobanja" in Sokobanja, where besides diagnostic procedures (such as spirometry that is as a ratio between two parameters' FEV1/FVC named as FVC - forced vital capacity and FEV1 - forced expiratory volume per 1 second), passed through the educational program and treatment of respiratory rehabilitation (that included the diet with limited food calorie intake in the range from 1200 to 1800 kcal, physical activity twice a day with mat exercises, breathing exercises, extended breathing exercises, aqua fitness program and walking tracks).

Survey results were analyzed using a software program for statistical analysis of data (SPSS). We used standard statistical parameters: arithmetic mean (Xsr.), standard deviation (SD), Fisher and Hi2-test, Student's t-test, linear correlation, multivariate linear regression, whereby the results are presented in tables and graphs.



Graph 1. Mean values and standard deviations of FEV1/FVC in the examined groups at the beginning (F=619,259; p<0,001) and end of 180 days (F=685,548; p<0,001) (ANOVA test, t-test for repeated measures)

Table 1. Lung capacity in patients with reduced body weight by more than 10% and in those without body weight reduction - in patients with COPD (Mann-Whitney U test).

	Reduction of BW>10%		Insignificant reduction of BW			
	Mean (Me)	IR	Mean (Me)	IR	Z	P
ΔFVC	4,33(5)	6,50	0,99(2)	8	-2,661	0,008
ΔFEV1	7,38(12)	15,50	2,67(49	8,5	-2,826	0,005
ΔFEV1/FVC	4,27(6,81)	13,95	2,14(2,15)	5,22	-2,288	0,022

Table 2. Parameters of body mass indexes of patients presented by groups (ANOVA comparison test) A (1a vs 1b), B (1a vs 2), C (1a vs 3), D (1a vs 4), E (1b vs 2), F (2 vs 3), G (2 vs 4), H (1b vs 3), I (3 vs 4)

	Group 1a		Group 1b		Group 2		Group 3		Group 4	
	X	SD	X	SD	X	SD	X	SD	X	SD
Height^{A,C,D,E}	1,64	0,05	1,78	0,03	1,68	0,06	1,75	0,1	1,77	0,06
Weight^{A,D,E,H,F,G,I}	87,1	13,9	103,6	17	79,6	16,5	90,5	12,3	110,5	10,9
Waist circumference^{A,D,E,H,F,G,I}	94,5	12,6	109,1	20,9	88,1	13,1	96,2	9,53	116,7	10,9
BMI$^{B.E.G.I}$	32	4,88	32,66	5,54	28,1	5,7	29,9	5,84	35,1	2,82

Results

Graph 1 presents mean values and standard deviations of FEV1/FVC in the examined groups at the beginning (F=619,259; p<0,001) and end of 180 days (F=685,548; p<0,001) (ANOVA test, t-test for repeated measures). Comparing the values at the beginning FEV1/ FVC and after a period of 180 days, statistically significant differences in the values of the analyzed groups were observed.

The lowest values at the beginning of testing were reported in group 4 (66,71±4, 53), which were significantly lower compared to the groups 1a (96, 87±3,45) and 1b (98, 10±3,77) but without significant difference compared to the values in group 2 (69,1±5,98). Statistically significant increase in the value at the end of the test occurred first in the group 2 (72,6±6,12) t=3,969; p<0,01, then in the group 3 (70,69±5,81) t=2,403; p=0,020 and in the group 4 (68,43±5,25) t=2,175; p=0,034, which

is marked by asterisks in the graph for p<0,05 (*) i p<0,01 (**), while for groups 1a (95,84±3,16) and 1b (98,22±3,55), this phenomenon has not been confirmed. This clearly shows that there are no significant differences in the spirometric values of the parameter FEV1/FVC that reflects the lung function between patients from groups 2, 3 and 4 and therefore we can conclude that obesity affects the decrease in spirometric parameters in patients with COPD.

Table 1 shows lung capacity in patients with reduced body weight by more than 10% and in those without body weight reduction - in patients with COPD (Mann-Whitney U test).

Table 1 shows the values of lung capacity and its decrease in patients before and after the treatment and rehabilitation (group of patients with COPD). The patients were divided in two groups. The first group involved the subjects whose body weight was reduced by more than 10%, and the other group included the examinees whose body weight did not significantly change.

As the data are very heterogeneous, for easier observation of changes of measured capacity, the change is shown by an average value, and median in parentheses, the interquartile difference as a measure of variability.

We could perceive the average increase in FVC after the treatment and rehabilitation of 4.33 in the group in which there was the reduction of TM and only 0.99 in those cases where there was no change in TM. Statistically significant difference was observed (Z=- 2.661, p=0.008).

A change in FEV1 occurred more frequently in patients with a decrease in TM (7.38 vs. 2.67, Z =- 2.826, p=0, 005).

The FEV1/FVC ratio increased by 4.27 in one group and 2.14 in the other group of patients (Z=- 2.288, p=0.022). This clearly shows that there was no significant difference in the values of the parameter FEV 1 / FVC, which reflects the lung function among subjects of groups 2, 3 and 4. We can therefore draw a conclusion that obesity does not affect the decrease in spirometric parameters in patients with COPD.

Table 2 shows the values of observed parameters related to obesity. By comparing the height between the analyzed groups, there is a statistically significant difference (F=17,663, p<0,0001). Patents in groups 3 (1,75±0,10), 4 (1,77±0,06) and 1b (1,78±0,03) had higher values of body height compared to patients in group 1a (1,64±0,05), while the body height values in the groups 2 (1,68±0,06) and 3 were lower than in group 1b. Statistically significantly higher values of height were reported in group 4 compared to group 2.

Statistically significant differences in body weight were also noticed among the analyzed groups (F=35,392, p<0,0001). The highest body weight values were reported in patients in group 4 (110,46±10,92), which was statistically significantly higher compared to group 1a (87.10±13.89), group 2 (79,56±16,46) and group 3 (90,46±12,33). The lowest body weight measurements were recorded in group 2 examinees, that was statistically lower than in the groups 1b (103,55±17,03), 3 and 4.

By applying the analysis of variance, statistically significant differences between the investigated has been observed by comparing the waist scope (F=36,996, p<0,0001). The largest waist scope was recorded in 4 group patients (116,74±10,92), which is statistically significantly higher compared to examinees in groups 1a (94,45±12,63), 2 (88,08±13,14) and 3 (96,16± 9,53). The lowest waist scope was found in group 2, and it was statistically lower than in subjects of groups 1b (109,10±20,86), 3 and 4.

Discussion

Observing the data obtained in a large number of studies dealing with defining the important parameters characteristic of people with COPD and obesity, as well as the inter-relationship and influence of these two diseases, it was concluded that the following methodological parameters have important role in examining, determining the relationships and understanding the interaction of these two diseases.

The obesity-related parameters are: age when obesity begins, duration of obesity until the beginning of investigations, degree of obesity, presence of abdominal obesity; the COPD-related parameters are: FEV1, FEV1/FVC, 6-minute test, duration of cigarette smoking, length of COPD until the beginning of investigations, presence of dyspnea, the number of exacerbations of COPD during one year, sputum volume ejected during one year.

Numerous studies conducted so far have not shown significant differences in spirometric parameters between the degree of obesity, and subjects with normal body weight.

Obesity significantly influences the life quality of COPD patients, affects the frequency of dyspnea, reduces physical fatigue threshold, affects the occurrence of frequent exacerbations, but its direct influence on the values of spirometric parameters has not been proved yet. This fact has initiated the investigations into the relationship between obesity and spirometric parameters. Furthermore, it helped introducing significant methodological parameters important for the management of COPD (6).

Influence of weight reduction on dyspnea, tolerance exercises and quality of life in overweight and obese patients with COPD has not yet been significantly described in the literature. There are studies showing that weight loss leads to improved lung function and symptoms, regardless of the degree of obstructive changes in the respiratory system (7, 8).

Given results have shown that the length of obesity with tendency to increase in the reported period is a significant negative predictor for lung function of the observed performance (p>0.001), (the ratio of FEV1/FVC (p>0.001) and diffusion capacity (p>0.001) (9).

By analyzing the spirometric parameters of FEV1 values, it has been observed that the obese examinees had better results which amounted to 50.0%, i.e. 20.4% of predicted amount, compared to normal patient whose FEV 1 was on average 44.2%, i.e. 19, 4% of predicted amount (10) .

Conclusions

1. Obesity has no significant effect on spirometric parameters in patients with COPD.

2. Losing weight in favor of adipose tissue reducing has a significant effect on improving the spirometric parameters in patients with COPD.

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UTICAJ GOJAZNOSTI NA SPIROMETRIJSKE PARAMETRE KOD BOLESNIKA SA HRONIČNOM OPSTRUKTIVNOM BOLEŠĆU PLUĆA

Miroljub Đorđević

Emisija štetnih aero čestica (teška industrija, termo i nuklearne elektrane, prevozna sredstva koja sagorevaju fosilna goriva, profesionalno eksponiranje u fabrikama i rudnicima, konzumacija cigareta…), u mnogome remeti funkciju respiratornog sistema. Gojaznost je udružena sa hroničnom inflamacijom niskog stepena i povećanim brojem aktiviranih makrofaga u masnom tkivu. Masno tkivo daje obilje inflamatornih medijatora, što sugeriše moguću povezanost gojaznosti sa imunološkim desavanjima u HOBP-u.

Cilj rada bio je utvrditi da li gojaznost ima značajan uticaj na spirometrijske parametere kod bolesnika sa HOBP-om i da li smanjenje telesne težine na račun smanjenja adipoznog tkiva ima pozitivan efekat na poboljšanje spirometrijskih parametara kod bolesnika sa HOBP-om.

Ispitivanjem je obuhvaćeno 190 ispitanika starosti od 35 do 65 godina oba pola, podeljenih u četri grupe. Prvu grupu činilo je 40 ispitanika različitog stepena gojaznosti bez verifikovane HOBP i to (1a) sa prisutnom gojaznošću od I (ITM 30-35) do III (ITM >40) i (1b) sa prisutnom pred-gojaznošću (ITM 25-30). Drugu grupu (2) činilo je 50 ispitanika, koji imaju normalnu uhranjenost i verifikovanu HOBP različite dužine trajanja. Treća grupa (3) od 50 ispitanika imala je gojaznost I stepena (ITM od 30-35) i verifikovanu HOBP i četvrta grupa (4) od 50 ispitanika oba pola imala je gojaznost II stepena (ITM od 35-40) i verifikovanu HOBP.

Vremanski interval u kome su trijažirani bolesnici za dato istraživanje iznosio je tri godine i odnosi se na period od 2007. do 2010. godine. Ispitanici su praćeni 180 dana, zajedno sa svim promenama vezanim za spirometrijske parametre i indeks telesne mase (ITM).

Poređenjem srednjih vrednosti i standardnih devijacija za FEV1/FVC odnos između: grupa 4 (66,71 ± 4,53), 2 (69,1 ± 5,98) i 3 (70,69 ± 5,81), nije uočena značajna statistička razlika. Upoređujući vrednosti spirometrijskih parametara između dve grupe bolesnika sa HOBP-om. Prve (1) u kojoj su bili ispitanici koji su uperiodu od 180 dana imali gubitak telesne mase veći od 10% i druge (2) u kojoj su bili ispitanici bez značajnog gubitka u telesnoj masi. Ustanovljeno je da su ispitanici iz prve grupe imali statistički značajno povećanje vrednosti svih posmatranih spirometrijskih parametara u odnosu na drugu grupu: FVC: 4.33(1) 0.99(2); $p<0,01$. FEV1: 7.38(1) 2.67(2); $p<0.01$. FEV1/FVC: 4,27(1) 2,14(2); $p<0,05$.

Gojaznost nema značajan efekat na spirometrijske parametre u bolesnika sa HOBP. Redukcija telesne težine i količine masnog tiva ima značajan efekat na popravljanje spirometrijskih pokazatelja sa HOBP. Acta Medica Medianae 2011;50(4):11-16.

Ključne reči: *gojaznost, odnos, hronična respiratorna bolest pluća (HOBP), spirometrijski parametri, indeks telesne mase (ITM)*