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PULMONARY FUNCTION OF ARMED FORCES MEMBERS IN MONTENEGRO AMONG DIFFERENT AGE GROUPS

PLJUČNA FUNKCIJA PRIPADNIKOV OBOROŽENIH SIL ČRNE GORE V RAZLIČNIH STAROSTNIH SKUPINAH

ABSTRACT

The results of numerous medical studies and kinesiology research show the existence of differences in the pulmonary function with reference to age, body height and size and the relation of certain parameters of body composition. The aim of this research is to determine eventual differences in the health and pulmonary function with soldiers of different age. The sample of examinees consisted of 240 members of Montenegro Armed Forces, having between 18 to 57 years of age, divided into 8 subsamples of 30 examinees each (following the age category). The sample of measures were made of the following indicators of pulmonary function: 1) Forced Vital Capacity, 2) Forced Expiratory Volume in 1 second, 3) the proportion of Forced Expiratory Volume in 1 second and the Forced Vital Capacity and 4) Peak Expiratory Flow. The central and dispersion parameters of variables were calculated for all variables. For examining the potential differences between the subsamples of examinees, and for determining the actual source of variability between the groups, multivariate and univariate analysis of the variance were applied, as well as the post hoc test with Tukey's model. Statistically significant differences were determined in pulmonary function compared to the age of soldiers. The pulmonary function of soldiers from 18 until 21 years of age differ from the soldiers of the next three age categories. Also, were determined that the next three variables mostly contribute to that difference: Forced Vital Capacity, Forced Expiratory Volume in 1 second and the Peak Expiratory Flow. In the Forced Vital Capacity were determined relatively constant values were detected from 32 until 52 years of age of the soldiers. The obtained results confirm the effect of numerous specific factors in the system of functioning of the military organization.

Keywords: Pulmonary function; Differences; Soldiers; Age

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IZVLEČEK

Rezultati številnih medicinskih študij in kinezioloških raziskav kažejo, da obstajajo razlike v pljučni funkciji glede na starost, telesno višino in povezanostjo nekaterih parametrov telesne sestave. Namen te raziskave je ugotoviti morebitne razlike v zdravju in pljučni funkciji pri vojakih različnih starosti. Vzorec preiskovancev je sestavljalo 240 pripadnikov oboroženih sil Črne gore, starih od 18 do 57 let, razdeljenih v 8 skupin po 30 preiskovancev (po starostnih kategorijah). Vzorec meritev je zajemal naslednje kazalnike pljučne funkcije: 1) forsirana vitalna kapaciteta, 2) forsirani ekspiratorni volumen v 1 sekundi, 3) razmerje med forsiranim ekspiratornim volumnom v 1 sekundi in forsirano vitalno kapaciteto, 4) maksimalni ekspiratorni pretok. Za vse spremenljivke so bili izračunani osrednji parametri in parametri razpršenosti spremenljivk. Za preučevanje morebitnih razlik med skupinami preiskovancev in za ugotavljanje dejanskega vira variabilnosti med skupinami sta bila uporabljena multivariatna in univariatna analiza variance ter post hoc test s Tukeyjevim modelom. Ugotovljene so bile statistično pomembne razlike v pljučni funkciji v primerjavi s starostjo vojakov. Pljučna funkcija vojakov, starih od 18 do 21 let, se razlikuje od vojakov naslednjih treh starostnih kategorij. Prav tako je bilo ugotovljeno, da k tej razliki največ prispevajo naslednje tri spremenljivke: forsirana vitalna kapaciteta, forsirani ekspiratorni volumen v eni sekundi in maksimalni ekspiratorni pretok. Pri forsirani vitalni kapaciteti so bile ugotovljene relativno konstantne vrednosti med 32 in 52 letom. Dobljeni rezultati potrjujejo vpliv številnih specifičnih dejavnikov v sistemu delovanja vojaške organizacije.

Ključne besede: pljučna funkcija, razlike, vojaki, starost

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INTRODUCTION

Lung volumes and capacities as a segment of functional capabilities of the body have great effect on a series of health-related processes (successively connected) such as: lung ventilation, gas diffusion and its transfer, gas exchange between blood and tissues and oxygen consumption in cells with the release of CO_2 (Davidovic et al., 1975). Functional diagnostics makes possible the insight in certain physiological and biochemical characteristics of human body. For the assessment of structurally functional characteristics of the respiratory composition, the spirometry tests are applied (Jukic, et al., 2008). Pulmonary Function Tests (PFTs) are usually used for the assessment of respiratory status and they have become a part of routine health examination with the respiratory, work and sports medicine (Kaur, Subhedar, Dave, Mishra and Sharma, 2015).

In his historical research, John Hutchinson (spirometer inventor) has determined that the age and height are the most important determinants of the lung function and since then many studies have confirmed that the lung function increases with the height and reduces with age (American Thoracis Society, 1991). Ageing results with the reduction of lung function and increase of body fat (Wiswell et al., 2001). Some of the studies have analysed the size or regional distribution of FM (body fat mass) and FFM (fat-free mass) compared to the lung function. With reference to the size, for FM it was noticed that it is negatively connected with the lung function, especially with very obese persons, while it is positively connected with FFM (De Lorenzo, Maiolo, Mohamed, Andreoli, Petrone and Rossi, 2001). With reference to distribution for the central or upper part of the body, it was noticed that FM is negatively connected with the lung function with elderly people. In addition, the results have shown that FVC (Forced Vital Capacity) and FEV1 (Forced Expiratory Volume measured during the first second) have significantly lower values with persons with the ratio of waist and hips (W/H) higher or equal to 0.95 (i.e. FM distribution of the upper body), compared to persons with W/H who have less than 0.95 (FM distribution of the lower body) (Collins, Hoberty, Walker, Fletcher and Peiris, 1995). Harik-Khan, Wise and Fleg (2001), have analysed the effect of W/H on FEV 1 and FVC in the research of a bigger population (around 1500 persons). After taking in consideration BMI and other variables, a strong reversible connection was confirmed between W/H and FEV1 with men, but not with women. Apart from this, it was confirmed that the higher W/H is connected with bigger reductions in FVC among men compared to women. Therefore, direct effects of distribution of body fat on the lung function look more pronounced among men. FM stored in the abdominal cavity most probably directly prevents diaphragm descent, increasing the weight to the walls of the thorax and leading to the restrictive respiratory disorder, as it is stated in this study. Such deficits represent a significant limiting factor for the members of the military service in the sense of efficiency for performing professional specialties, which depend on a series of external factors (Wiswell et al., 2001). Similar changes are present even in the other segments of body composition and they are the result, not only of the effect of specificity of a demanding military profession, but primarily of physiological and morphological changes connected to biological ageing (Sharp, Knapik and Wallker, 2008).

Based on the stated studies, it was determined that significant differences appear in lung volumes and capacities with people of different age. Bearing in mind the fact that the military organization represents a separate system with a wide variety of actions of various specific factors, the aim of this research was set. It includes the determination of health status and definition of eventual differences in the pulmonary function of the members of Armed Forced of Montenegro of different age groups. By achieving the set goal, important information from the aspect of indirect assessment of the functional capacities and health condition of the soldier's organism will be obtained. This will undoubtedly contribute to the adequate planning of transformation processes in soldiers, and their preparation for adequate task performance without the danger of endangering their health in that process.

METHODS

This Cross-sectional study consists of measurement of appropriate indicators for lung function of professional members of Armed Forces in Montenegro. A sample of 240 examinees, aged between 18-57, was divided into 8 age categories (table 1). An equal number of male respondents were taken from each unit of the Army of Montenegro by random sampling.

Table 1. Sample of examinees with reference to age.

Sample/ Age category	I	II	III	IV	V	VI	VII	VIII
Years of age	18-21	22-26	27-31	32-36	37-41	42-46	47-51	52-57
No of examinees	30	30	30	30	30	30	30	30
Years average	20.0	23.9	29.3	34.6	39.1	44.2	47.8	56.3

The assessment of lung function was made based on the analysis of spirometry indicators: Forced Vital Capacity (FVC), Forced Expiratory Volume measured during the first second (FEV1), the ratio of Forced Expiratory Volume measured during the first second and Forced Vital Capacity (FEV1/FVC) and Peak Expiratory Flow (PEF). Spirometry testing was made in accordance with the Protocol for functional diagnostics of soldiers (Jukic et al., 2008). For measuring parameters of the lung function the spirometer of the brand (Spirometrics. SMI 3) was used with the belonging program support QUARK b^2.

The obtained results have been first of all arranged and then statistically processed on a personal computer under the software statistical package SPSS 20.0 (Chicago, IL, USA). The central and dispersion variable parameters have been calculated, and in order to analyse potential differences in the lung function between the subsamples of examinees, a Multivariate Analysis of Variance (MANOVA) was realized, while as the second step, to determine the differences between groups on individual variables, an Analysis of Variance (ANOVA) was applied. To determine the real source of variability between groups, a further analysis realized the procedure which tested individual differences between each of the calculated arithmetic means, i.e. a classic variance analysis (F-test) was supplemented by post hoc test with Tukey's model for determining differences (Tukey's Honestly Significant Difference test-HSD). The realized level of significance for previously stated statistical procedures is $p \leq 0.05$.

RESULTS

In table 2 have been shown the basic statistical descriptive parameters of the lung function of professional soldiers of Montenegro Army for different age groups. It can be noted that Forced Expiratory Volume, Forced Expiratory Volume measured during the first second and the ratio of Forced Expiratory Volume during the 1st second and the Forced Vital Capacity, have the highest values in age group II and the lowest values in age group VIII. On the other hand, the Peak Expiratory Flow parameter shows the highest values in group III and the lowest values in age group I.

Table 2. Central and dispersion variable parameters of the lung function of soldiers of different age.

Age	Variable	Min	Max	Mean	SD
I age group (18-21)	FVC	3.94	7.10	5.10	.688
	FEV1	1.74	6.10	4.13	.905
	FEF	36.0	98.6	81.2	15.45
	PEF	1.8	12.5	6.6	2.78
II age group (22-26)	FVC	4.37	6.74	5.49	.634
	FEV1	3.73	6.10	4.66	.643
	FEF	67.2	99.9	85.0	8.63
	PEF	4.1	12.5	8.6	2.79
III age group (27-31)	FVC	4.15	6.96	5.44	.710
	FEV1	2.38	5.68	4.45	.760
	FEF	46.6	92.4	81.82	9.39
	PEF	2.3	24.9	9.26	4.17
IV age group (32-36)	FVC	3.98	6.39	5.16	.655
	FEV1	3.34	5.29	4.23	.510
	FEF	67.9	97.9	82.62	6.82
	PEF	3.6	12.5	9.23	2.75
V age group (37-41)	FVC	3.34	6.57	4.93	.821
	FEV1	2.87	5.71	4.13	.616
	FEF	61.7	97.9	84.46	8.06
	PEF	5.0	12.5	8.93	2.58
VI age group (42-46)	FVC	3.62	6.53	5.13	.670
	FEV1	2.41	5.07	4.11	.675
	FEF	43.0	92.6	80.50	10.25
	PEF	3.1	12.5	8.64	3.29
VII age group (47-51)	FVC	2.91	6.49	4.85	.900
	FEV1	2.09	5.04	3.86	.691
	FEF	50.7	99.9	80.37	10.44
	PEF	2.8	12.5	8.16	2.96
VIII age group (52-57)	FVC	3.23	5.68	4.63	.604
	FEV1	1.24	4.65	3.60	.791
	FEF	24.9	99.9	77.97	15.39
	PEF	1.7	12.5	7.09	3.25

Note: Min – minimum result; Max – maximum result; Mean – arithmetic mean; SD – standard deviation; FVC – Forced Vital Capacity; FEV1 – Forced Expiratory Volume measured during the first second; FEF – the ratio of Forced Expiratory Volume during 1st second and the Forced Vital Capacity; PEF – Peak Expiratory Flow.

By testing the significance of lung function variable differences between subsamples of examinees with reference to age group, a statistically significant difference was established, since the value of Wilks Lambda amounted .722, which during F approximation 2.79 gives difference significance at the level $P<0.05$ (table 3).

Table 3. MANOVA parameters of lung functions of soldiers with reference to the age group.

Wilks'Lambda test	F value	P significance level
.722	2.79+	**.000***

Note: * – existence of significant differences

With the insight in table 4, it was concluded that such difference results from the following variables: Forced Vital Capacity, Forced Expiratory Volume measured during the first second and Peak Expiratory Flow.

Table 4. ANOVA parameters of soldiers' lung function with reference to age group.

Variable	F value	P significance level
FVC	4.84	**.000***
FEV1	6.31	**.000***
FEF	1.32	.240
PEF	2.87	**.007***

Note: * – existence of significant differences

Based on the results of Tukey's test for the variable Forced Vital Capacity shown in table 5, it was established which groups significantly deviate in the analysed variable compared to the others. Those are: soldiers of II age group (FVC=5.49) compared to soldiers: of VII age group (FVC=4.85) and of VIII age group (FVC=4.63); Soldiers of III age group (FVC=5.44) compared to soldiers: of VII age group (FVC=4.85) and of VIII age group (FVC=4.63).

Table 5. Tukey's test for the variable Forced Vital Capacity (FVC).

p	II	III	IV	V	VI	VII	VIII
I	.416	.604	1.00	.983	1.00	.878	.190
II		1.00	.649	.054	.532	**.015***	**.000***
III			.818	.112	.719	**.036***	**.001***
IV				.907	1.00	.690	.084
V					.956	1.00	.753
VI						.794	.129
VII							.939

Note: I-VIII – age groups; p – significance level; * – existence of significant differences.

Based on the result of Tukey's test for the variable Forced Expiratory Volume measured during the first second (FEV1) shown in table 6, it was established which groups significantly deviate in the studied variable compared to the others. Those are: Soldiers of II age group (FEV1=4.66) compared to the soldiers: of VII age group (FEV1=3.86) and of VIII age group (FEV1=3.60); Soldiers of III age group (FEV1=4.45) compared to the soldiers: of VII age group (FEV1=3.86) and of VIII age group (FEV1=3.60); Soldiers of IV age group (FEV1=4.23) compared to soldiers: of VIII age group (FEV1=3.60).

Table 6. Tukey's test for the variable Forced Expiratory Volume measured during the first second (FEV1).

p	II	III	IV	V	VI	VII	VIII
I	.084	.675	.999	1.00	1.00	.825	.074
II		.945	.287	.081	.064	**.001***	**.000***
III			.939	.664	.607	**.035***	**.000***
IV				.999	.998	.476	**.014***
V					1.00	.833	.077
VI						.873	.096
VII							.831

Note: I-VIII – age groups; p – significance level; * – existence of significant differences.

Based on the results of Tukey's test for the variable Peak Expiratory Flow (PEF) shown in the table 7, it was established which groups significantly deviate in the studied variable compared to the others. Those are: Soldiers of I age group (PEF=6.60) compared to soldiers: of III age group (PEF=9.26) and of IV age group (PEF=9.23).

Table 7. Tukey's test for the variable Peak Expiratory Flow (PEF).

p	II	III	IV	V	VI	VII	VIII
I	.222	**.033***	**.038***	.103	.238	.607	1.00
II		.995	.997	1.00	1.00	.998	.513
III			1.00	1.00	.994	.867	.127
IV				1.00	.996	.886	.141
V					1.00	.979	.302
VI						.999	.536
VII							.888

Note: I-VIII – age groups; p – significance level; * – existence of significant differences.

DISCUSSION AND CONCLUSION

The analysis of respiratory function in this study is limited to lung ventilation (entering and exiting of air from the lungs), which represents the first out of four segments in the process of breathing physiology (Guyton, 1985). However, it was determined that the lung volumes and capacities which the lung ventilation depends on, are very important for the function of the complete respiratory system (Banjevic, 2021). The elasticity of the lung tissue and walls of the thorax is being reduced with age (Haywood and Getchell, 2017). In addition, the quantity of mass component which is being increased with age in the part of abdomen, by acting on diaphragm brings to the reduction of lung capacity (Harik-Khan, Wise and Fleg, 2001).

The results obtained in this study show the statistically significant differences in the Forced Vital Capacity (FVC) between the members of Montenegro Army of II and III age group on one, i.e. of VII and VIII age group on the other side. These differences show that the value of the said parameter is dropping from the third to the fifth and sixth life decades of soldiers for 0.72 l. It is proved that the average reduction of the Forced Vital Capacity with aging is 4-5% per life decade with people of different occupations from general population (Norris, Shock, Landowne and Falzone, 1956; Shepard, 1978). However, although there are similarities in the scope of changes over the years, their dynamics differ significantly among professional members of the VCG (compared to the general population). Namely, by using the obtained average values of the Forced Vital Capacity per age groups, we obtained the data shown in table 8.

Table 8. Value reduction (FVC) with the members of Montenegro Army.

Scope of age of members of Montenegro Army	Life decade	Dropping (FVC %) for 1 life decade
22 to 32	III	7.0%
32 to 42	IV	
32 to 42	IV	0.05%
42 to 52	V	
42 to 52	V	7.2%
52 +	VI	

Therefore, minimum fall of the Forced Vital Capacity is registered between IV and V life decade, which really means that it has relatively constant values from 32nd until 52nd year of age of the soldiers. Bearing in mind the established positive correlations between the Forced Vital Capacity (FVC) and the aerobic capacity (Hollmann, 1972), as well as the fact that the basis of the physical potentials of soldiers is made of aerobic capacity and muscle strength (Sharp, Knapik and Wallker, 2008) in this way obtained results are of extreme importance when making and practically implementing effective training processes for soldiers of different age. In addition, special attention should be given to soldiers in the sixth life decade since in that period happens the decrease of the maximum respiratory minute volume, maximal oxygen uptake and maximal oxygen debt (Guyton, 1985). This kind of decrease of lung vital capacity and parameters of aerobic capability cannot be compensated by training (Johnson, Saupe and Dempsey, 1992), but can be significantly delayed by applying the adequate and moderate physical activity (Blair, 1990). In that way the maintaining of professional work capability would be secured with older soldiers, but also the preservation of their health status. Namely, the results of epidemiological research have given evidence that there is direct connection between the levels of aerobic capability and the frequency of morbidity and mortality, first of all from cardiovascular and some malignant diseases (Blair, Horton, Leon, Lee, Drinkwater and Dishman, 1996). The results of these, as well as numerous other studies were the reason for which the World Health Organization (Federation Internationale de Medicine Sportive and World Health Organization, 1995) has marked the reduced level of aerobic capability as the independent reversible factor of health risk, the share of which in unnecessary getting sick and premature death can be compared with other risk factors such as hypercholesterolemia, hypertension and smoking.

The differences have been established with reference to the age and when we are talking about the respiratory indicator the Forced Expiratory Volume measured during the first second (FEV1). The same have appeared as in case of Forced Vital Capacity (FVC), with additional ratio between IV and VIII age group. Here, it was also confirmed that during the aging process which causes certain changes on respiratory organs (the loss of elasticity of lung tissue), there happens the linear uniform dropping of values of air quantity expired during the first second all until 47th year of age. Then a more drastic decrease of this value can be noticed, but its relation towards the vital capacity (Tiffeneau Index) shows that there are no obstructive ventilation disturbances neither with older soldiers. This type of data is important from the aspect of applying certain content of physical training, however, we should bear in mind that the respiratory system is not the only factor of limiting the capacity for exercising with older persons (Haywood & Getchell, 2017). Here, first of all we think about cardiovascular changes and the process of losing the muscular mass, which leads to the condition that the maximum capability for exercising and the maximum oxygen consumption decrease with the age, and the recovery time after intensive activity is being extended (Spirduzo, 1975). In accordance with the data Kohl, Gibbons, Gordon and Blair (1990), with clinically healthy persons, without subjective symptoms, upon maximum efforts during the ergometric testing, the signs of myocardial ischemia are noticed with 4% of persons of the age 40-45, and even in 20% with the ones of the age between 50 and 55. This is why Humphries, Dietrick, Palan and Smith (1989), propose before performing the running tests, that the army members should complete a specifically made questionnaire, which in their opinion, would make possible the detection of health risk for maximal physical efforts.

With the variable Peak Exporatory Flow (PEF), which relates to the quality of respiratory passageways flow, a deviation is confirmed of the soldiers of III and IV age group compared to soldiers and age groups. Namely, they have the higher value of this parameters for 2.66 i.e. 2.63 than the soldiers of up to 21 years of age. If we look at the average values and other respiratory indicators, with the soldiers of I age group lower values are noticed compared to the soldiers of II, III and IV age group. These kind of differences are possible to be explained with the current morphofunctional processes with young soldiers and the fact that they are “transferred” to the military organization from the civil one, where in a majority of cases they were not subject to the application of everyday professional and methodical physical training. Namely, the parameters of lung function are subject to changes during the growth and development, where they reach the highest values in the period of younger mature age (22-28 years of age). Until such period, depending on the process of individual development of the body, and especially depending on the systematic body exercise, its size is being changed with each individual (Stojanovic, 1987). Therefore, the results of this study have just shown that the time from 18 until 21 years of age of a soldier represent a sensitive period to increase the parameters of lung function, and by that also the aerobic capability of their body. By not diminishing the importance of other elements of physical fitness, the aerobic capability of the army members is especially important for two basic reasons: it is accepted as the international standard of general physical fitness (International Committee for the standardization of physical fitness test, 1974), and recently the level of aerobic fitness is more and more seen as a health category (Blair, Horton, Leon, Lee, Drinkwater and Dishman, 1996). Bearing in mind the above mentioned, a clear recommendation is given to the military organization that in the period of initial military training the emphasis is on developing soldiers’ fitness potential, first of all of their aerobic capacities. In this way a good basis shall be ensured for a later upgrade of other elements of physical form (health prevention ass wel).

In accordance with the obtained results, it is possible to conclude the following: Relatively constant values have been established of Forced Vital Capacity with soldiers from 32nd until 52nd year of age, which indicates a different dynamics of change of lung function parameters compared with the general population. In addition, based on the difference in the lung function of soldiers from 18th until 21st year of age compared to soldiers of the next three age groups, this period of their life can be marked as the sensitive period for the development of the lung function in the conditions of specific military training. With this, it is undoubtedly confirmed the effect of numerous specific factors in the training system and the realization of specific purpose tasks in the army.

The results of this research represent a contribution in the direction of clarifying the health condition of lung function of the members of Montenegrin Army. It would be significant to realize a more extensive study where the realtion of morphological characteristics and lung function parameters of soldiers with reference to age, army branch and military specialty would be studied. This study is especially important due to the type of treated sample, which can be characterized as a selected population, so their data cannot be compared with the general population, which could relate in a certain way also to the limitation of the study in the sense of possibility of a wider application of the obtained results. However, taking in consideration a great importance of the army as a special part of social community, the theoretical and practical value of this research is unquestionable.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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