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Original Article

The influence of morphofunctional condition on the physical fitness level of Ukrainian soldiers

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Abstract:
The article presents a comparative analysis of the main components of the physical condition of military personnel with different physical fitness levels. The 170 soldiers with an average age of 19.6 years took part in the study. The study was aimed at identifying the structure of the relationships among morphological status, cardiovascular function and the most important physical abilities. The following methods were used: anthropometric; physiological, pedagogical, and mathematical statistics. Results. The analysis of the main parameters of physical development indicated statistically significant difference ($p<0.05$; $p<0.01$) between the studied groups of soldiers with different physical fitness levels. The group with a high level of physical fitness had significantly higher values of body height, chest circumference, and right/left hand grip strength (p<0.01), while having a lower body weight ($p<0.05$). The analysis of the average values of five skinfold measurements and their sum indicated statistically significant difference between the groups with different physical fitness levels (p<0.05; p<0.01). The group of soldiers with a low level of physical fitness had higher ($p<0.01$) values of five skinfold measurements and their sum. The obtained average group values of body composition indicate a statistically significant difference ($p<0.05$; $p<0.01$) in the muscle and fat components, and basal metabolism between the groups with different levels of physical fitness. Analysis of the average group values of soldiers with high and medium levels of physical fitness showed the optimal function of the cardiovascular system and a well-developed system of external respiration. The correlation analysis revealed a large number of high direct and inverse relations with r from 0.172 at p <0.05 to 0.662 at p <0.001 between morphofunctional status and major physical abilities of soldiers. Also, we found that 3000m run results (endurance) directly depends on the body height, vital capacity, saturation, and the leg muscle mass (r = 0.167; r = 0.168; r = 0.169; r = 0.217 at p <0.05). Furthermore, inverse relations were found between these parameters and fat component (r from -0.164 to -0.338 at $p<0.05$; $p<0.01$; $p<0.001$). We found that the effectiveness of strength test exercises was the most influenced by the body measurements and muscle component, as well as a strong inverse relation was found between the fat component and exercise effectiveness.
Key words: physical development, muscle component, fat component, cardio-respiratory system, physical fitness, motor skills.

Introduction

The improvement of weapons, military equipment and combat vehicles, as well as specific difficulties of military service increased the demands on the level of physical fitness of soldiers (Kimmons, 2018; Petrachkov, 2013a). The most important components of physical readiness are the following: strength, endurance, military-applied motor skills, as well as mental qualities (Petrachkov, 2013b). A number of scientific studies (Petrachkov, Finogenov, 2013) which analysed the daily routine of soldiers indicate that physical development, functional state of the cardio-respiratory system and the level of physical performance affect the combat effectiveness of personnel and the effectiveness of professional activities. It was found (Petrachkov, Finogenov, 2013) that the soldiers with high physical fitness level performed combat training tasks including shooting much more efficiently and faster than those with a low physical fitness level do. During military exercises close to combat, physical activity increases significantly and for soldiers with a low level of physical fitness it becomes quite difficult to perform actions related to maneuvers on the battlefield, which generally has a negative impact on the overall effectiveness of combat exercises (Petrachkov, 2011). Analysis of scientific publications of a number of authors (Banjevic, 2020; Mykhaylov, 2021; Klymovych et al, 2020a) allows us to conclude that one of the ways to improve the physical development and functional status of soldiers is the formation of basic physical training based on the predominant development of strength and endurance.

Among the scientific publications there are a number of studies in which the authors point to the significant effectiveness of military shooting and combat training of soldiers with high sports qualifications and continue to train in the chosen sport (Oderov et al, 2020; Klymovych et al, 2020a). In this population, much less

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time is spent on mastering special military skills and tactical, fire, technical, combat training. At the same time, achieving high learning outcomes and the ability to act effectively and stably in the most difficult situations is also characteristic of persons with a high level of physical fitness (Martins, 2018). Thus, the impact of the physical fitness of personnel on the level of combat readiness of units is manifested directly through the physical ability of soldiers to perform their functional duties. Since the level of physical fitness is usually assessed by the development of basic physical skills, it remains relevant to determine the impact of morphological status of soldiers on the level of development of motor skills, including strength, speed, and endurance.

Material and methods

Participants - The 170 soldiers took part at our pedagogical experiment at September 2021 that was held at the National Defence University of Ukraine named after Ivan Cherniakhovskyi (NDUU). The average age of the participants was 19.6 years. Three groups of soldiers were formed according to the results of five Army Physical Fitness Tests: the first group (G1) with a high physical fitness level (n=56), the second group (G2) with a medium physical fitness level (n=57) and the third group (G3) with a low physical fitness level (n=57). The soldiers were involved in the pedagogical experiment voluntarily with the written consent of the publication of their personal data during the review and coverage of the results. The study was conducted in accordance with the ethical principles of the Helsinki Declaration of the World Medical Association.

Research methods- In accordance with the research aim, we used anthropometric methods to measure the parameters of physical development in compliance with international standards. We measured body length (*BL*) in centimetres to the nearest 1 cm, body weight (*BW*) in kilograms to the nearest 100 grams, circumferential dimensions of the shoulder, chest, waist and hips in centimetres to the nearest 1 mm. The dynamometer was used to determine the strength of right and left hands in kilograms. The study of the five skinfolds was performed using a mechanical calliper to the nearest 1 mm. The body composition was studied using the Japanese Tanita BC-545 N polysigment analyser (18 parameters). Body composition was fractionated into fat, muscle and bone components. In the research, we used a set of methods to assess the functional state of the cardiovascular system. We used traditional methods of AND UA-888E automatic tonometer to determine the integral indicators of the circulatory system, in particular: determination of resting heart rate (HR_{rest}), resting systolic and diastolic blood pressure (SBP_{rest}, DBP_{rest}) using. In addition, traditional research methods were used to control the functional state of the respiratory system. Vital capacity of the lungs (*VC*) was measured using a portable spirometer in compliance with all sanitary standards. The level of oxygen saturation of capillary blood was non-invasively measured by LK87/88/89 fingertip pulse oximeter that was put on the end phalanx of the finger or toe. Indicators of 96% and above were taken as the norm.We used an orthostatic test to obtain the objective information about the tone of the sympathetic division of the autonomic nervous system during the transition of the body from a horizontal to a vertical position by the HR difference. The results were evaluated by P.I. Gotovtsev method. According to its classification an increase of HR up to 10 BPM^{-1} is consider to be 'excellent'; an increase of 11÷16 BPM^{-1} is 'good'; an increase of 17÷20 BPM^{-1} is 'satisfactory'; an increase of 22 BPM^{-1} and above and the reduction of the result by 2÷5 BPM^{-1} is 'unsatisfactory'. The verification and the assessment of the soldier's physical fitness level were carried out with the 5 standard Army Physical Fitness Tests: 100m run, distance grenade throwing, 100m freestyle swimming**,** pull-ups, and 3000m run. The testing was held during scheduled physical training lessons.

Statistical Methods- The statistical data obtained during the study was processed using the computer software package Statistica 10.0 (StatSoft, Inc., USA) and Microsoft Excel. The proper statistical method was selected depending on the measurements scale and the number of samples. The average samples size were as following ($30 \leq n \leq 100$), so we checked the normality of the distribution by the Shapiro-Wilk test and the test of skewness and kurtosis coefficients. Kruskal–Wallis one-way analysis of variance non-parametric method was used for the samples with non normal distribution. We used statistical analysis, which involved calculating the arithmetic mean (*M*) and the standard deviation (*SD*). Significant differences were tested by Student's t-test for independent samples, the reliability for all studies was set at no less than $p \leq 0.05$. Correlation analysis of the obtained data was performed using a linear Pearson's Correlation Coefficient.

Results

In accordance with the aim of the research, we analysed the group results of anthropometric data without comparison with the age norms. We had the opportunity to compare the soldiers' results between groups because our sample of subjects was divided into three groups according to the physical fitness levels. The parameters of physical development of soldiers are presented in table 1. The soldiers from the G1 have significantly higher average group results ($p<0.05$; $p<0.01$) of *BL*, *BW*, chest circumference, handheld dynamometry (right and the left hands) than the soldiers from the G2 with a medium physical fitness level. At the same time, low average group indicators of skinfolds and their sum characterize the G1. Soldiers from the G3 have the highest average group scores of *BW*, circumferences (waist, pelvic and thigh), and five skinfolds and their sum.

Table 1. Average group indicators of physical development of Ukrainian soldiers with different physical fitness levels, (*n*=170)

Parameters	Group 1, (*n*=56)		Group 2, (*n*=57)		Group 3, (*n*=57)	
	M	*SD*	*M*	*SD*	*M*	*SD*
BL, cm	181.5 ^{aa}	6.46	175.1	6.88	176.6**	7.93
BW, kg	78.8 ^{aa}	8.16	71.5 ^{bb}	10.59	80.7	8.83
Shoulder circumference, cm	32.2	2.47	31.4	3.11	31.9	3.47
Chest circumference, cm	99.0 ^{aa}	7.73	94.7 ^{bb}	8.15	98.7	5.15
Waist circumference, cm	79.7	5.37	77.9 ^{bb}	4.53	82.7**	5.14
Pelvic circumference, cm	97.3 ^{aa}	4.60	94.0 ^{bb}	3.31	99.8**	5.08
Thigh circumference, cm	55.6	3.46	54.3 ^{bb}	5.40	58.1**	4.71
Handheld dynamometry (right hand), kg	54.6 ^{aa}	3.38	48.8	2.41	49.6**	3.88
Handheld dynamometry (left hand), kg	49.2 ^{aa}	2.34	45.7 ^{b}	2.71	48.0	3.95
Biceps skinfold, mm	4.3	1.34	5.5 ^{bb}	0.64	8.7**	0.85
Triceps skinfold, mm	9.6	0.21	8.7 ^{bb}	1.00	14.3**	0.02
Subscapular skinfold, mm	11.4	0.82	10.6 ^{bb}	0.22	16.3**	0.21
Suprailiac skinfold, mm	12.0 ^{a}	0.81	9.8 ^{bb}	0.78	16.6**	1.51
Medial (inside) calf skinfold, mm	8.4 ^{aa}	0.46	6.3 ^{bb}	0.41	9.6	0.46
The sum of skinfolds, mm	45.6 ^{a}	2.65	40.8 ^{bb}	3.32	65.5**	4.58

Note: significant differences according to Student's t-test: ^{a}p<0.05, ^{aa}p<0.01 – between the G1 and G2; *p<0.05, **p<0.01 – between the G1 and G3; ^{b}p <0.05, ^{bb}p <0.01 – between the G2 and G3

Fractionation of *BW* into the main body components (fat, muscle and bone) provides much more meaningful data about the physical development (Shklyar A.S., 2014). The component body composition being one of the aspect of the morphological constitution reflects the state of body metabolic processes and can be an indicator of various pathological abnormalities.

The protocol of analysis of body composition using Tanita BC-545 N polysigment analyser allowed us to analyse 18 indicators. The results of the study are presented in table 2. The average group *BMI* results of the soldiers with high and medium physical fitness levels are in the range of normal by a gradation scale, while this parameter of soldiers with low physical fitness level is classified as overweight. Statistically significant difference (p<0.05; p<0.01) between *BMI* parameters of the studied groups of soldiers was found. It is known from the literature that it is not appropriate to use the *BMI* in studies of men and youth who go/do/play sports, because of it is uninformative for this category of We received the detailed data about soldiers' lipid metabolism by the analysis of the total fat body content. The fat people (Shklyar, 2014) component of human body weight is one of the indicators of its nutritional (alimentary) status, which changes dynamically under the influence of various factors (Shklyar, 2014). The average group results of the soldiers with high and medium physical fitness levels are in the same digital range and correspond to the physiological norm, while the average group results of the soldiers with low physical fitness level is significantly (p<0.01) higher and indicates the fat mass excess. In addition, we find the asymmetry in the right and left hand during analysing the fat mass distribution in all three groups, the difference ranges from 0.7% to 1.0%.

Table 2. Average group indicators of the body composition of Ukrainian soldiers with different physical fitness levels (*n*=170)

Parameters	Group 1, (*n*=56)		Group 2, (*n*=57)		Group 3, (*n*=57)	
	M	*SD*	*M*	*SD*	*M*	*SD*
BMI, kg/m-2	23.9	2.13	23.6 ^{bb}	3.61	25.9**	2.80
Total fat,%	12.4	0.00	12.4 ^{bb}	0.14	15.6**	4.71
Right hand fat,%	13.3	0.52	12.9 ^{bb}	0.59	14.7*	3.35
Left hand fat,%	14.0	0.91	13.6 ^{bb}	0.07	15.7**	3.74
Body fat,%	11.7	0.81	11.3 ^{bb}	0.39	16.2**	6.20
Right leg fat,%	12.6	0.80	13.6	0.59	14.3**	3.36
Left leg fat,%	13.3	0.82	14.0	0.23	15.0*	3.44
Total water,%	63.2	3.68	64.1 ^{bb}	3.90	60.2**	4.01
Muscle mass,%	78.3 ^{aa}	3.82	70.2 ^{b}	3.90	66.2**	4.48
Right hand muscle mass, kg	3.9 ^{aa}	0.52	3.5 ^{bb}	0.48	2.9**	0.35
Left hand muscle mass, kg	3.9 ^{aa}	0.56	3.4 ^{bb}	0.54	2.7**	0.34
Torso muscle mass, kg	35.6 ^{aa}	0.84	32.1 ^{bb}	0.52	30.1**	0.85
Right leg muscle mass, kg	11.3 ^{aa}	1.05	10.2 ^{bb}	1.03	9.2**	0.84
Left leg muscle mass, kg	10.9	1.01	9.9 ^{bb}	1.08	8.9**	0.83
Assessment of body constitution, points	5.6	0.78	5.4	0.60	5.4	0.89
Bone mass content, kg	3.4 ^{aa}	0.33	3.1 ^{bb}	0.32	3.4	0.23
Basal metabolism, kcal	2055.0 ^{aa}	213.07	1847.0 ^{bb}	202.19	2019.3	166.09
Visceral fat content,%	1.9	0.18	2.0 ^{bb}	0.13	3.0**	0.36

Note: significant differences according to Student's t-test: ^{a}p<0.05, ^{aa}p<0.01 – between the G1 and G2; *p<0.05, **p<0.01 – between the G1 and G3; ^{b}p<0.05, ^{bb}p <0.01 – between the G2 and G3

The total water content is the largest by weight body composition at the molecular level. Normally, the total water content is in the range of 45% to 60% of total body weight in young men and women. The average group results of the total water content of soldiers with different physical fitness levels are within the norm. Among the studied groups, we did not find soldiers with a deficiency of the bone component, and the average group results of this parameter correspond to the physiological norm. The muscular component of human body weight is one of the body composition and an indicator of its structural and functional state at the stages of ontogenesis. In practice, the body components value without the fat component is a correlate of motor activity and physical performance. Low level of muscle and bone components of healthy persons are considered to be hypodynamic signs.

The average group result of muscle mass content of the soldiers with a high physical fitness level is higher than the physiological norm and statistically significant ($p<0.05$; $p<0.01$) higher in comparison with the group of soldiers with medium and low physical fitness levels. No soldiers from three groups had deficiencies of muscle component. It was found that the soldiers with high physical fitness level had no asymmetry in the distribution of muscle mass between the right and left hand, while in G2 the asymmetric distribution is 0.1 kg and in G3 – 0.2 kg. The distribution of the leg muscle component indicates the dominance of the right leg in all three groups, the difference is 0.3÷0.4 kg, and may indicate the need to correct physical activity during physical fitness lessons. The average group results of the assessment of body constitution of soldiers with different physical fitness levels were in the same medium level according to the gradation scale. The intensity of metabolic processes and the activity of physiological functions (including HR, and respiratory rate) depend on body composition.

The average group results of the basal metabolism in the studied groups with different physical fitness levels had a statistically significant difference between G1 and G2; and between G2 and G3 ($p<0.01$). It should be noted that this parameter indicates the daily calorie intake to ensure the basal metabolism, metabolism, which is associated with daily activities and is individual for each.

The next stage of our research was a comparative analysis of the indicators of the cardio-respiratory system of soldiers, the results are presented in Table 3.

The average group results of HR_{rest} at all three groups are within physiological norms. A statistically significant difference ($p<0.01$) is observed between G1 and G3 and G2 and G3 of the subjects. The obtained results of HR_{rest} of G1 and G2 of soldiers indicate the optimal mode of operation of the cardiovascular system. We considered the physiological norms of blood pressure for soldiers according to the recommendations of the WHO, which offers the following parameters, 110-130/70-80 mmHg. The results of blood pressure at rest at all three groups of soldiers correspond to physiological norms, among the studied sample there are no persons with hypotension signs ($BP<110/70$ mmHg). In the G3 of soldiers, who are characterized by a low physical fitness level, we found 12.3% ($n=7$) of persons with signs of hypertension ($BP>130/80$ mmHg). It should be noted that the optimal blood pressure is the most important factor of the normal functioning of the cardiovascular system. This indicator is constantly under the control of various regulatory mechanisms, as indicated by research results (Nekhanevich, 2015) in response to any deviation of blood pressure from normal, there are numerous reflex reactions that lead to changes in minute blood volume and total peripheral resistance to return the blood pressure to its normal value.

Table 3. Average group indicators of the cardio-respiratory system of Ukrainian soldiers with different levels of physical fitness (*n*=170)

Parameters	Group 1, (n=56)		Group 2, (n=57)		Group 3, (n=57)	
	M	*SD*	*M*	*SD*	*M*	*SD*
HR_{rest}, BPM^{-1}	65.3	2.19	65.8^{bb}	3.98	72.4^{**}	4.84
SBP_{rest}, mm Hg	122.0	5.40	119.3	6.49	121.8	6.15
DBP_{rest}, mm Hg	72.2	7.94	71.9	7.22	72.6	7.48
Orthostatic test, BPM^{-1}	9.0^{a}	0.83	12.7^{bb}	0.91	18.9^{**}	0.57
VC, ml	5192.9^{aa}	536.85	4932.1^{b}	581.88	4522.8^{**}	411.45
Saturation, %	97.8	1.29	97.7	1.33	97.8	0.80

Note: significant differences according to Student's t-test: $^{a}p<0.05$, $^{aa}p<0.01$ - between the G1 and G2; $^{*}p<0.05$, $^{**}p<0.01$ - between the G1 and G3; $^{b}p<0.05$, $^{bb}p<0.01$ - between the G2 and G3

Analysis of the results of the orthostatic test indicates a statistically significant difference ($p<0.05$; $p<0.01$) between the studied groups of soldiers. The average group result of orthostatic test in soldiers of the G1 according to the gradation scale is at the 'excellent' level, the difference in heart rate between horizontal and vertical body position was 9.0 BPM, in the G2 the average group result corresponds to 'good' and in the G3 according to the gradation scale, the result corresponds to the 'satisfactory' level. We can state that the third group of soldiers with a low level of physical fitness has increased reactivity of the sympathetic part of the autonomic nervous system, which is characteristic of insufficiently trained persons.

According to the purpose of the study, the next stage of our research was to establish the structure of the relationship between morphological and functional status and the main motor tests that characterize the development of strength, speed, endurance. The results of the relationships are presented in table 4. Our correlation analysis indicates the presence of a large number of high direct and inverse relationships that are at the level of r = 0.271÷0.653 at *p*<0.001. The results of the test exercise in the 3000m run in the military directly depends on body length, lung capacity, saturation, and muscle mass on the legs, correlation coefficients are in the range r = 0.167÷0.217 at *p*<0.05. The presence of high inverse correlations in the range r = -0.164÷-0.338 at *p*<0.05; *p*<0.01; *p*<0.001 indicate a significant effect of the fat component on the effectiveness of 3000m run. Analysis of the relationships of the test exercise in the 100m run indicates 16 direct and 15 inverse correlation relationships, which are at the level of r = -0.181÷0.649 at *p*<0.05; *p*<0.01; *p*<0.001. The high speed of overcoming this distance is influenced by indicators that characterize the total body size, fat, muscle and bone components of the body, indicators that characterize the cardiovascular system, including the mechanisms of the sympathetic part of the autonomic nervous system. The result of throwing a grenade at a distance in the military depends on 20 variables that have a direct correlation and 10 variables that have an inverse correlation. It should also be noted that the high dependence of the effectiveness of the test exercise on the muscle component, the correlation coefficients are in the range from r = 0.547÷0.662 at *p*<0.001, as well as body weight, girth, pelvis, thigh, right handheld dynamometry brush, correlation coefficients are in the range from r = 0.323÷0.483 at *p*<0.001. High performance during a 100m swimming test is influenced by 12 variables that have a direct correlation and 16 variables that have an inverse relationship.

Table 4. Correlation relationships between indicators of morphological and functional status of Ukrainian soldiers and basic motor tests (*n*=170)

Parameters	100m run	Grenade throwing	100m swimming	Pull-ups	3000m run
BL, cm	0.15	0.154	**0.570****	-0.155	**0.217***
BW, kg	**0.461****	**0.480****	**-0.320****	**-0.291***	**-0.164**
Shoulder circumference, cm	**0.332****	0.143	-0.147	-0.104	-0.014
Chest circumference, cm	**0.448****	**0.461****	**0.217***	0.064	0.02
Waist circumference, cm	**0.305****	**0.291****	**-0.199**	**-0.232***	0.032
Pelvic circumference, cm	0.15	**0.323****	**-0.278****	**-0.246***	0.032
Thigh circumference, cm	**0.448****	**0.483****	-0.116	**-0.341****	**-0.195**
Handheld dynamometry (right hand), kg	**0.169**	**0.340****	-0.054	0.013	0.000
Handheld dynamometry (left hand), kg	0.005	**0.185**	-0.08	-0.04	0.004
Biceps skinfold, mm	**-0.226***	-0.108	**-0.394****	**-0.305****	**-0.309****
Triceps skinfold, mm	-0.031	**-0.250***	**-0.323****	**-0.382****	**-0.372****
Subscapular skinfold, mm	**-0.445****	**0.290****	**-0.282****	**-0.254***	**-0.256***
Suprailiac skinfold, mm	**-0.518****	**0.271****	**-0.303****	-0.157	**-0.297****
Medial (inside) calf skinfold, mm	**-0.267****	0.132	**-0.405****	**-0.330****	**-0.304****
The sum of skinfolds, mm	**-0.406****	0.157	**-0.390****	**-0.308****	**-0.361****
BMI kg · m-2	**0.421****	**0.434****	0.04	**-0.232***	0.045
Total fat content,%	**-0.181**	**-0.286****	**-0.293****	-0.11	0.129
The fat content of the right hand,%	**-0.379****	**-0.337****	**-0.181**	**-0.219***	0.127
Left hand fat content,%	**-0.356****	**-0.382****	-0.118	**-0.299****	0.102
Body fat content,%	-0.14	**-0.272****	**-0.341****	-0.029	**-0.162**
The fat content of the right leg,%	**-0.187**	**-0.227***	**-0.203**	**-0.218***	0.049
The fat content of the left leg,%	**-0.204**	**-0.286****	**-0.183**	**-0.219***	0.031
Total water content,%	0.03	0.119	**0.361****	0.112	-0.136
Muscle mass content,%	**0.552****	**0.607****	**0.195**	**0.249***	0.108
Muscle mass of the right arm, kg	**0.644****	**0.653****	**0.159**	0.146	0.096
Left arm muscle mass, kg	**0.649****	**0.662****	**0.172**	0.122	0.099
Torso muscle mass, kg	**0.517****	**0.591****	**0.195**	**0.290****	0.07
Muscle mass of the right leg, kg	**0.510****	**0.547****	**0.186**	**0.21**	**0.169**
Left leg muscle mass, kg	**0.546****	**0.585****	**0.205**	**0.217***	**0.182**
Assessment of body constitution, points	**0.383****	**0.372****	**0.275****	**0.217***	-0.003
Bone mass content, kg	**0.537****	**0.585****	**0.224***	**0.271****	0.108
Basal metabolism, kcal	**0.535****	**0.583****	**0.231***	**0.268***	0.155
Visceral fat content,%	**-0.247***	**-0.178**	**-0.294****	**-0.564****	**-0.338****
HR_{rest}, BPM^{-1}	**-0.311****	**-0.197**	**-0.172**	0.052	0.146
SBP_{rest}, mm Hg	**-0.280****	0.059	-0.07	**-0.240***	-0.053
DBP_{rest}, mm Hg	**-0.411****	-0.126	0.076	**-0.182**	-0.153
Orthostatic test, BPM^{-1}	**-0.352****	**-0.277****	0.034	-0.154	-0.076
VC, ml	-0.151	**0.219***	**0.556****	**0.285****	**0.167**
Saturation,%	**0.341****	0.001	0.022	0.006	**0.168**

Notes: rcp = 0.159; r = 0.172 at p <0.05; r = -0.217 at p <0.01; r = 0.271 at p <0.001; * - correlation coefficient statistically significant at the level of p <0.01; ** - correlation coefficient statistically significant at the level of p <0.01.

It should also be noted the high dependence of swimming results on *BL* and *VC*, the correlation coefficients are in the range r = 0.556÷0.570 at *p*<0.001. The fat component has a negative impact on the effectiveness of this standard. 25 variables with direct and inverse correlation affect the performance of strength exercises, in particular pull-ups in the military. High inverse correlations were found with the fat component, body weight, girth, waist, hips, correlation coefficients in the range r = -0.232÷-0.341 at $p<0.01$; $p<0.001$. Thus, the results obtained indicate a significant impact of morphological and functional status of soldiers on the effectiveness of control tests and standards of physical fitness.

Discussion

The results of the study confirmed and supplemented the already known developments in terms of the problem studied. Furthermore, the extended analysis of the experimental data is somewhat limited due to the small number of studies involving armed forces personnel, since such studies are sometimes not available in free access. A number of scientists (Oderov et al, 2022) studied the level of physical training of soldiers at the initial stage of training. They indicated the relationship between the development of basic motor skills and speed of professional combat missions. A number of scientific publications (Burley et al, 2018; Oderov et al, 2020; Klymovych et al, 2020a), which were aimed at the study of physical training of soldiers of different military specialties indicate that the higher the level of physical fitness of soldiers, the more effective the tasks of combat and shooting training. In scientific publications (Klymovych et al, 2020b, Mykhaylov, Korostylova, 2021) was experimentally confirmed that the functional capabilities of the body affect the physical fitness level, which in turn helps to improve the professional skills of soldiers. The results of the study show a close relationship between the body composition and physical fitness in US army soldiers (Russell et al, 2018, Shiozawa et al, 2019). The importance of taking into account the volume of physical activity to improve physical development and physical fitness of soldiers was indicated in the works of Schilz and Sammito (2021). The issue of increasing the level of physical fitness of armed forces personnel through weight reduction and improvement of body composition was the subject of the study by Pierce et al (2021). The generalization of the obtained data (Canino et al, 2019; Davis et al, 2020; Kyrolainen et al, 2018) confirms the utility and relevance of research aimed at assessing the influence of morphofunctional indicators on the level of physical fitness.

Physical fitness is an important characteristic of health, an integral indicator of human physical activity (Petrachkov, 2013c; Andrieieva et al, 2019, 2020; Hakman et al, 2020; Drozdovska et al, 2020). It is known that when exercising, almost all organs and systems of the body interact (Paliichuk et al, 2018). By regulating the set of health and training loads, it is possible to purposefully influence the stimulation of certain systems, thereby increasing the level of their functioning and, accordingly, the physical fitness level (Petrachkov et al, 2021; Petrachkov, Yarmak, 2021).

Conclusions

The results of scientific research indicate high indicators of the functional state of the cardiovascular and respiratory systems of soldiers with a high physical fitness level. The average group indicators of heart rate at rest of soldiers with different physical fitness levels are in the range from 65.3 to 72.4 beats per minute, which indicates the optimization of the cardiovascular system. High average group vital signs of lung capacity in the first group of soldiers indicate a well-developed system of external respiration. The average group results of the body composition, including fat, muscle and bone components of the soldiers of G1 and G2 are within physiological norms. Conversely, in G3 of soldiers, who are characterized by a low physical fitness level, there is an increase of the fat component. We have established significantly high correlations between the morpho-functional indicators of soldiers and the results of five test exercises that characterize strength, speed, and endurance. Correlation coefficients ranged from r=0.172 at $p<0.05$ to r=0.662 at p<0.001. It can be stated that the greatest impact on performance during exercise is influenced by indicators that characterize the total size of the body, fat and muscle components, as well as indicators that reflect the work of the cardiovascular and respiratory systems.

Conflict of interest

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

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