

FEATURES OF FUNCTIONAL PARAMETERS OF MARTIAL ARTS ATHLETES

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Annotation

This article presents the results of bicycle ergometry and spirometry tests on athletes practicing judo and freestyle wrestling to determine the functional characteristics of Uzbek athletes.

Keywords

wrestling, functional testing, spirometry, PWC 170.

Introduction: One of the key indicators of an athlete's preparedness is maximum oxygen consumption (VO_{2max}). This indicator characterizes the body's ability to provide muscles with oxygen and use it effectively when performing maximal intensity work, thereby characterizing the state and development of the cardiorespiratory system [1]. Bicycle ergometry exercise tests provide the opportunity to determine VO_{2max} or VO_{2peak} values under controlled laboratory conditions. This ensures high objectivity in assessing the athlete's aerobic potential and allows tracking changes in functional indicators under the influence of training [8].

In martial arts, where the ability to recover quickly between power and striking episodes plays an important role, a high level of VO_{2max} helps maintain performance and reduce fatigue throughout the bout. Functional diagnostics of the body solves a wide range of tasks—from determining general physical endurance to justifying the choice of sports specialization. Analysis of the obtained data makes it possible to predict sports results, as well as to develop preventive measures aimed at reducing the level of injuries and the development of pathological conditions [6].

Among the existing methods for studying the functional state of the cardiovascular system, bicycle ergometry occupies a key place. This method is highly informative in assessing both aerobic and anaerobic functions of the body, as well as the degree of adaptation of physiological systems to physical exertion. The results of exercise testing are used to determine the level of physical performance of athletes.

Table 1.

Physical performance of martial arts athletes

Athlete's weight (kg)	Low level	Below average	Average	Above average	High
60–69	< 999	1000–1199	1200–1599	1600–1799	> 1800
70–79	< 1149	1150–1349	1350–1749	1750–1949	> 1950
80–89	< 1299	1300–1499	1500–1899	1900–2099	> 2100

According to WHO expert estimates, $VO_2\text{max}$ is considered one of the most objective markers of the functional state of the cardiorespiratory system, the characteristics of metabolic processes, and the magnitude of the body's aerobic reserve [5]. Modern sports are characterized by a significant increase in training loads, an increase in competitive activity, and the complication of technical execution of exercises. In this regard, the role of developing general and special endurance, as well as heart adaptation, significantly increases. Aerobic mechanisms of energy supply play a predominant role in ensuring high performance and the body's resistance to physical exertion [2, 3]. The results of functional diagnostics, including bicycle ergometry tests, allow determining not only PWC 170 and $VO_2\text{max}$ indicators but also assessing the morpho-functional characteristics of the heart. According to a study by WASE (World Alliance of Societies of Echocardiography), the stroke volume value in healthy adults is 68.7 ± 17.0 ml. In men, this indicator reaches 74.3 ± 17.2 ml, while in women it is 62.5 ± 14.3 ml [9]. A meta-analysis showed that the norm of the indexed left ventricular end-diastolic volume (LV EDV) varies between 60–109 ml/m² in men and 56–96 ml/m² in women [7]. External respiration, along with the circulatory system, is classified among the systems that limit physical performance. In sports that require great endurance, athletes must possess high aerobic capabilities. Therefore, spirometry parameters can act as conditional, genetically determined markers of predisposition to engaging in sports requiring increased endurance. Parameters of the respiratory system are usually classified as conditional genetic markers, as they can change during a person's life as a result of training, but the limits of their variability are genetically determined [4].

Purpose, Materials, and Methods

Purpose: To study the functional state of athletes engaged in boxing, judo, and freestyle wrestling.

Materials and Methods: The study was conducted in 2025 at the Republican Scientific and Practical Center for Sports Medicine. Within the framework of an in-depth medical examination, male and female representatives engaged in freestyle wrestling and judo were examined.

* The study involved 21 male judokas aged 23.7 ± 0.68 years and 17 male freestyle wrestlers aged 21.47 ± 0.4 years.

* Also studied were 9 female judokas aged 20.30 ± 0.59 years and 16 female athletes engaged in freestyle wrestling aged 21.50 ± 0.6 years.

The examination was conducted in the pre-competitive period of the annual training cycle. Functional research methods such as spirometry and bicycle ergometry were carried out as part of the in-depth medical examination. In spirometry, the following parameters were studied: FVC (Forced Vital Capacity); The total volume of air that can be exhaled with a maximal forced exhalation effort. FEV1 - Forced Expiratory Volume in 1 second; the volume of air exhaled during the first second after a maximal inhalation. FEV1/FVC ratio - The percentage of Vital Capacity exhaled in one second. MVV- Maximum Voluntary Ventilation; The volume of air that a subject can voluntarily move (inhale + exhale) in a given short period of time (usually 12 seconds), with maximum frequency and depth of breathing, multiplied by a coefficient to obtain the value for 1 minute [6]. ERV -Expiratory Reserve Volume; The maximal volume of air exhaled at the end of a normal expiration; IRV -Inspiratory Reserve Volume; The maximal volume of air inhaled at the end of a normal inspiration; PEF Peak Expiratory Flow, The maximum flow during the FVC test must be achieved within 100 milliseconds after the start of the FVC test. MMEF (Forced Mid-Expiratory Flow between the 25th and 75th percentile of FVC), an indicator of the airflow velocity in the “middle” part of the forced expiration. It is often

used as an indicator of the state of the small airways. SVC - Slow Vital Capacity; the volume of air that a person can exhale slowly and completely after the deepest inhalation, without effort. IVC (Inspiratory Vital Capacity); the volume of air that a person can maximally inhale after a slow, complete exhalation [2,7].

All obtained data were processed using software tools "Microsoft Excel 2016" and "Statistica 13", which allowed for a comprehensive statistical analysis of the results.

Results and Discussion: Analysis of physical performance in young men showed an average physical performance in the represented sports. Significant differences were established in the results of PWC 170 between freestyle wrestling and judo among girls ($p < 0.05$). Significant differences were also found in VO_2 max results between freestyle wrestling and judo among girls ($p < 0.05$). The value of the maximum stroke volume of blood (maxQs), calculated mathematically in all athletes, significantly exceeds the average values of individuals not involved in sports. A significant difference was established between the indicators of maximum stroke volume of blood in girls engaged in wrestling and judo ($p < 0.05$). The heart volume in our studies showed values higher than those of individuals not involved in sports.

Significant differences in heart volume (HV) were found in male athletes between judokas and boxers ($p < 0.01$), as well as significant differences in heart volume (HV) in females between wrestling and judo ($p < 0.05$).

The best functional indicators of the cardiovascular system were established in males, however, no significant differences between wrestlers and judokas were detected. Significant differences were established according to PWC 170 results in females engaged in judo and freestyle wrestling, moreover, female judokas possess the best indicators of cardiovascular system functioning. (Table 2)

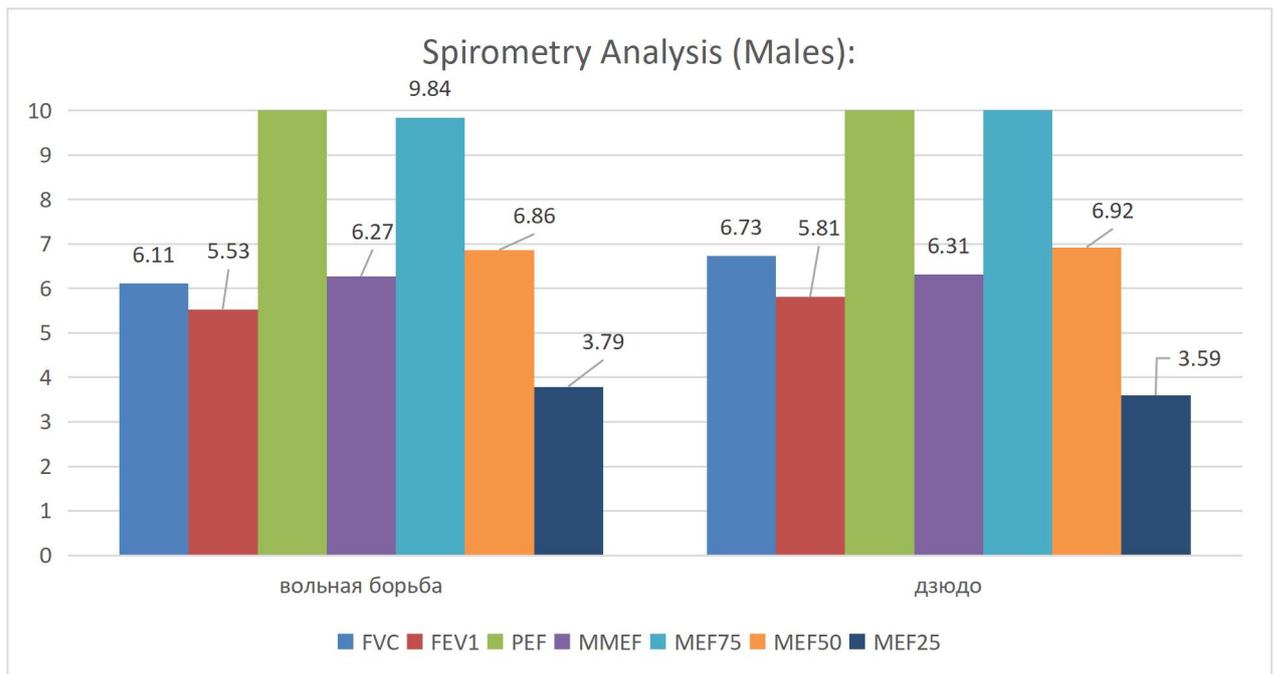
Table 2

Functional indicators of athletes engaged in freestyle wrestling and judo

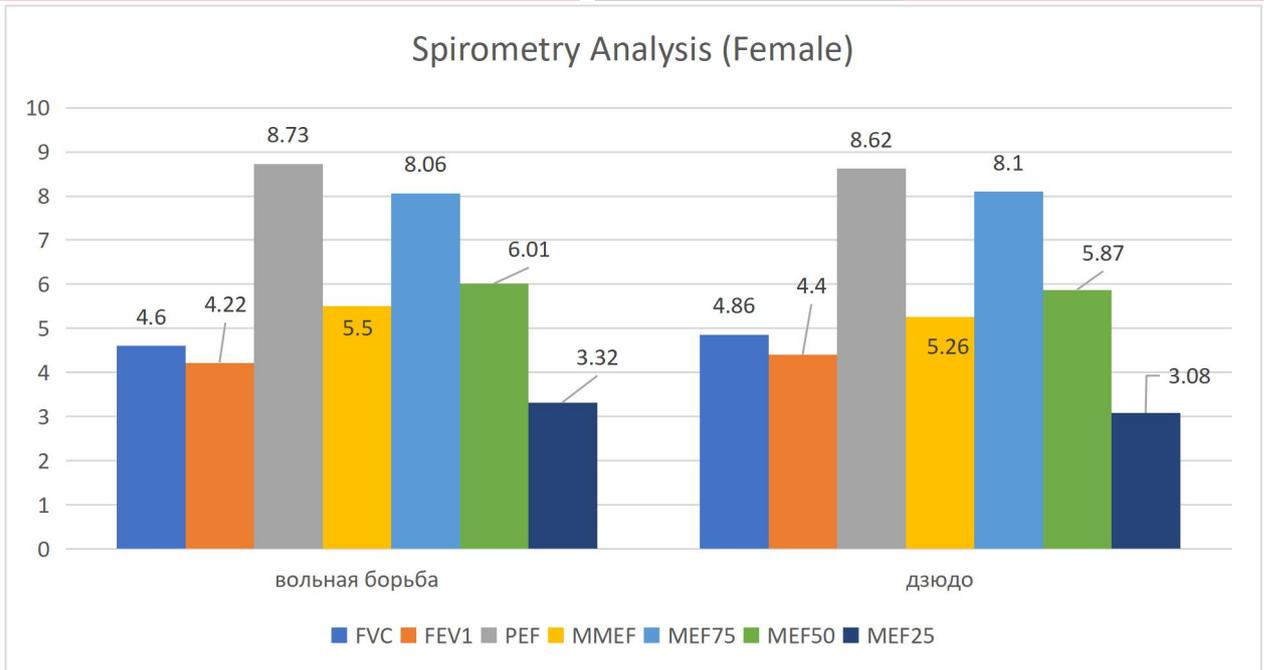
Group	Age	Weight (kg)	PWC 170	HV	MIHK	maxQ
Young men						
Male	M±m	M±m	M±m	M±m		
Freestyle wrestling	21,47±0,40	78,11±4,02	1594,2±105,15	990,95±36,89	4577,34±231,33	152,54±8,41
Judo	23,71**±0,6	88,80±4,93	1814,92±95,82	1056,58±23,56	5062,83±210,80	170,19±7,6
Young girls						
Freestyle wrestling	21,50±0,5	62,25±1,99	1069,99±71,96	757,00±38,60	3423,99±158,31	110,60±5,7
Judo	20,30±0,5	65,88±4,3	1282,01*±73,2	881,02*±40,05	3890,35*±161,13	127,54*±5,87

* Statistically significant differences by Student's t-test at a significance level of $p < 0.05$, at a significance level of $p < 0.01$ relative to the control group, * at a significance level of $p < 0.001$ relative to the control group.

Our studies showed that forced vital capacity (FVC) in young men practicing freestyle wrestling is 19.1% higher than the average values for individuals of this age, and in judokas, it is 24.4% higher; forced expiratory volume in one second (FEV1) in "freestylers" exceeds average standard values by 26.25%, and in judokas by 26.3%; peak expiratory flow (PEF) in freestyle wrestling is 9.04% above the norm, and in judo - 13.75% above. The mid-expiratory flow rate (MMEF) in freestylers is 21.1% above the norm, and in judokas - 19.5% above the norm. The airflow velocity in small bronchi upon reaching 25%, 50%, and 75% of forced vital capacity in young men practicing freestyle wrestling is 25.5%, 22.7%, and 19.7% above the norm respectively; for judokas, this ratio is 44.10%, 42.48%, and 28.67% (Figure 1).



Forced vital capacity (FVC) in girls practicing freestyle wrestling is 22.9% higher than the average values for individuals of this age, and in female judokas - 26.9% higher; forced expiratory volume in one second (FEV1) in girls practicing freestyle wrestling exceeds the norm by 29.05%, and in female judokas - by 32.93%; peak expiratory flow (PEF) in freestyle wrestling is 21.58% higher, and in judo - 19.2% higher than average values. The mid-expiratory flow rate (MMEF) in female "freestylers" is 29.71% above the norm, and in female judokas - 23.74% above the norm. The airflow velocity in small bronchi upon reaching 25%, 50%, and 75% of FVC in girls practicing freestyle wrestling is 28.13%, 30.65%, and 44.97% above the norm respectively; for female judokas, it is 28.16%, 26.78%, and 33.91% above the norm (Figure 2).



Significant differences were established in tidal volume (TV) between girls engaged in wrestling and judo ($p < 0.05$), and between males engaged in judo and freestyle wrestling ($p < 0.001$). Regarding the volume of air a person can maximally inhale after a slow, complete exhalation (IVC), significant differences were established between males practicing freestyle wrestling and judo ($p < 0.01$). Between young men practicing wrestling and judo, significant differences were found for the following values: SVC ($p < 0.05$), IVC ($p < 0.05$). The percentage of vital capacity exhaled in one second (FEV1/FVC) in freestyle wrestling is 9.22% higher, and in judo - 6.67% higher than the average values for this age.

The percentage of vital capacity exhaled in one second (FEV1/FVC) in freestyle wrestling is 8.39% higher than the norm, in judo - 3.94% (Table 3).

Table 3

Spirometry indicators of athletes engaged in freestyle wrestling and judo

	SVC	ERV	IVC	MVV	TV	FEV1/FVC
	M±m	M±m	M±m	M±m	M±m	M±m
Young men						
Freestyle wrestling	6,35±0,24	1,56±0,21	6,07±0,24	182,87±6,56	4,55±0,58	90,43±1,52
Judo	7,26*±0,30	1,05±0,18	6,88*±0,3	201,73±9,51	6,88***±0,3	86,72±1,43
Young girls						
Freestyle wrestling	4,70±0,25	1,12±0,13	4,49±0,22	154,88±10,08	3,3±0,04	91,87±1,99
Judo	4,83±0,39	1,14±0,16	4,68±0,34	152,37±8,31	4,68*±0,34	90,79±1,42

* Statistically significant differences by Student's t-test at a significance level of $p < 0.05$, at a significance level of $p < 0.01$ relative to the control group, * at a significance level of $p < 0.001$ relative to the control group

The volume of air that a male wrestler can exhale slowly and completely after the deepest inhalation, without effort (SVC), is 19.36% above statistical norms and 27.81% higher in judo among males. Expiratory reserve volume (ERV) in males practicing freestyle wrestling is 6% below the norm, and in judo, it is 38.6% below the norm. The volume of air that an athlete can maximally inhale after a slow, complete exhalation (IVC) in freestyle wrestling is 6.6% above the norm, and in judo - 21.1% above the norm. The volume of air that a subject can voluntarily move in a given short period of time with maximum frequency and depth of breathing (MVV) is 20.3% above the norm in freestyle wrestling, and 27.7% above the norm in judo. For females, the SVC in freestyle wrestling is 23.9% above the norm and 18.7% higher in judo. ERV in females practicing freestyle wrestling is 18.8% below the norm, and in judo, it is 69.7% below the norm. The IVC in female freestyle wrestlers is 23% above the norm, and in judo - 22.8% above the norm. The MVV in freestyle wrestling is 32.2% above the norm, and in judo - 30.01% among females (Table 3).

Conclusions: Among Uzbek martial arts athletes, males practicing judo possess the best functional parameters of the respiratory and cardiovascular systems, aerobic capabilities, and functional reserves. Among Uzbek female athletes, females practicing judo possess the best functional parameters of the cardiovascular system.

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