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**THE METROLOGICAL CHARACTERISTICS OF THE METERED LOADS OF
SPECIFIC NATURE OF DIFFERENT STYLE WRESTLERS**

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Abstract. *This study made it possible to determine the degree of exposure to the body of wrestlers of various styles of standard metered physical load of strength and speed-strength nature, namely: the value of muscle tension as a percentage of the athlete's own body weight, the reaction of the body (cardiorespiratory system) to the standard load of wrestlers of different weight categories and qualifications: heart rate, respiratory rate after exercise and the speed of recovery processes, indicators of physical performance, as well as exists a comparative analysis of the efforts of the wrestlers of different weight class and qualification in the performance of a standard metered physical load of specific character. The study made it possible to determine the power and volume of physical activity when determining the physical performance indicators of wrestlers, depending on the method of throwing and the method of determining physical performance indicators for wrestlers of various styles. The results of the study made it possible to establish the dynamics of the indicators of special endurance of wrestlers of various styles depending on the weight category and qualifications. And also to reveal the existence of differences, both between the indicators of the pulse at rest and after performing standard metered physical activity. In the course of the study, there was determined the duration of the return of heart rate to the initial level after performing a standard metered load of both non-specific and specific nature in wrestlers of various styles and the rate of adaptation processes to physical loads of strength and speed-strength nature occurring in the body of the examined athletes.*

Keywords: *pulse, physical working capacity, standard metered physical load of the specific nature, strength and speed-strength endurance, recovery time, motor qualities, physical performance, pulse sum of recovery processes, weight category, athletic qualifications.*

Relevance. In recent years, in the practice of world sports, some quantitative tests have been applied more and more widely, studying certain manifestations of the active state of the human body directly during muscular work. Herewith, it is distinguished between "maximum" (for example, the definition of the MOC) and "submaximal" tests (Sjostrand T., 1947, K. Lange Andersen, 1971). The latter are most acceptable for the current continuous assessment of the physical performance of athletes in the preparatory and competitive training periods [1, 2, 3].

When conducting tests with the use of specific loads, physiological shifts are determined by work aimed directly at maintaining the pace, rhythm and speed of movements, and the additional work that an athlete (wrestler) does to overcome external resistance, move his own body weight and equipment weight (wrestling dummy). The degree of physiological changes in the athlete's body caused by a specific physical load depends on the power of the load itself and a number of factors such as the performance of the cardiorespiratory system, the level of technical preparedness, the

athlete's body weight, and, in some cases, the weight of sports equipment, etc. [5, 9, 10].

The purpose of the study is to improve the system of training wrestlers at various stages of sports training.

This scientific research is based on the results of a systematic study of indicators of physical performance of athletes in the laboratory of the Center for Scientific Research in the Field of Physical Education and Sports (CSR FPES) of the State University of Physical Education and Sports. And, since 2006 - the study of the physical performance of wrestlers (men and women), which are specialized in various types of wrestling. During this period, the authors also carried out a number of special studies that improved the methodology for determining physical performance indicators of representatives of cyclic and speed-strength sports and contributed to the clinical and physiological substantiation of a number of fundamental provisions on this issue [8, 13, 14].

The objectives of the study. To achieve this goal, the following tasks were solved:

1. To study the methodology of monitoring the dynamics of the level of special physical fitness of wrestlers at various stages of sports training using specific tests.

2. To determine the metrological features of motor tasks of a specific nature during the PWC₁₇₀ test, for wrestlers of various styles.

Research methods:

- analysis of scientific and methodological literature;
- pedagogical observations of the educational process and the competitive activity of wrestlers of various styles [8, 12, 14];
- anthropometry (height, weight, length of the lower extremities);
- pedagogical testing (the amount of work performed in determining the indicators of PWC₁₇₀ (V. Karpman, Z. Belotserkovsky, I. Gudkov, 1988), heart rate by intervalometry method (I. Mruts, V. Uvarov, 1989), the pulse cost of test tasks and the pulse amount of

recovery processes (according to L. Brouha, 1964);

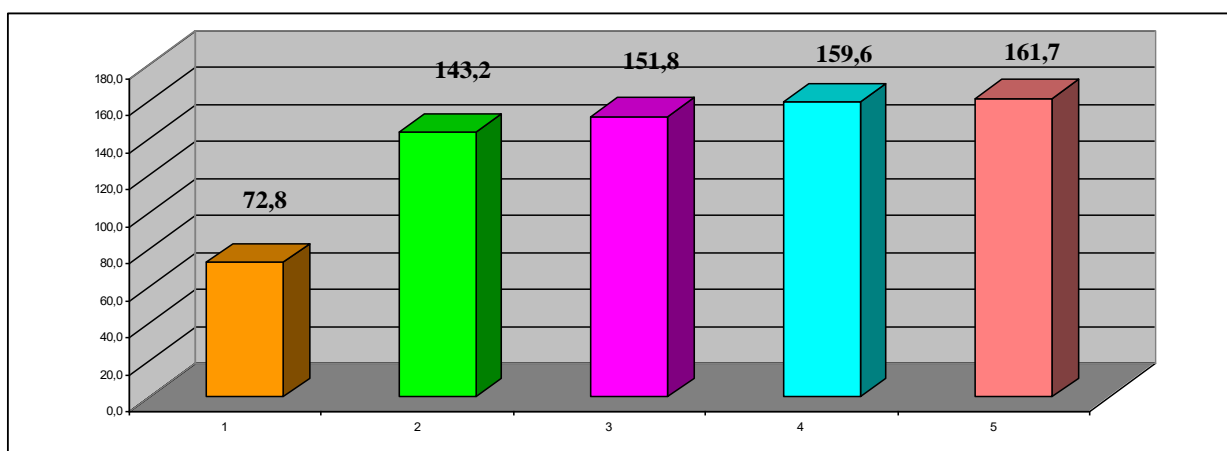
- mathematical and statistical data processing [16].

The results of the study. An important advantage of tests using specific loads is that they make it possible to judge not only about general, but also about special physical performance, the efficiency of performing movements, and also how productively the capabilities of various body systems are used in real sports conditions. [4, 5, 8, 12] At the same time, specific tests have some limitations related mainly to the standardization of the methodology for their implementation [4, 9, 12, 14, 15].

In the course of research, there was carried out an analysis of the motor activity of wrestlers of various styles during training sessions and sport competitions, there were carried out anthropometric measurements of wrestlers of various specializations and qualifications, there were determined the volume and intensity of physical activity and the degree of its impact on the body of wrestlers, there were also determined physical performance indicators of wrestlers during help step test, bicycle ergometry and using specific loads - deflection throw (Greco-Roman wrestling), over the spine (freestyle wrestling), over the shoulder (judo) and over the thigh (sambo) [1, 4, 6, 11]. The linear nature of these relationships allows to determine physical performance based on an analysis of the values of the speed of locomotion and the power of specific physical loads using special equipment (wrestling dummy). At the same time, the use of linear extra- or interpolation, taking into account the results of only two specific loads performed with moderate intensity and heart rate after each of these physical loads, makes it possible to determine in a relatively large linear range the indicators of physical performance inherent in this sport (Manolachi V., Mrut I., 2017).

Figure 1 shows the heart rate recorded after a standard step physical exercise - dummy throws weighing 40 kg with a frequency of 6 throws (cycles) per minute: after throws for 1 minute, after throws for 2 minutes (12 cycles), then 3 minutes (18 cycles) and, finally, after throws during four minutes (24 cycles). Each cycle includes actions performed in a strictly defined sequence: standing up a wrestler from a lying position (after completing a throw), raising a dummy

and placing it in an upright position, preparing for a throw (twisting, squatting, etc.) and throw itself with subsequent fall on the carpet. In addition, after each of the metered loads, the duration of heart rate recovery to the initial level was determined, as well as the dynamics of heart rate indicators during the recovery process, on the basis of which the pulse sum of the recovery processes and the so-called "pulse cost" of each of the metered loads were calculated.



Symbols: ■ - at rest; ■ -at the end of 1st min; ■ - at the end of 2nd minute.; ■ - at the end of 3rd minute; ■ -at the end of 4th minute

Fig. 1. Heart rate indicators of wrestlers (averaged data) when performing standard stepwise metered physical load (dummy throws)

To obtain objective and comparable results during dynamic observations, each test should be carried out in similar conditions using the same equipment and with a certain frequency. This is especially true for women - with strict regard to the athlete's personal calendar — OMC days (ovarian-menstrual cycle) and orthostatic test indicators, since the highest physical performance indicators are usually shown by women in the middle of the OMC (Kots Y.M., 1986, Manolachi V., 2003).

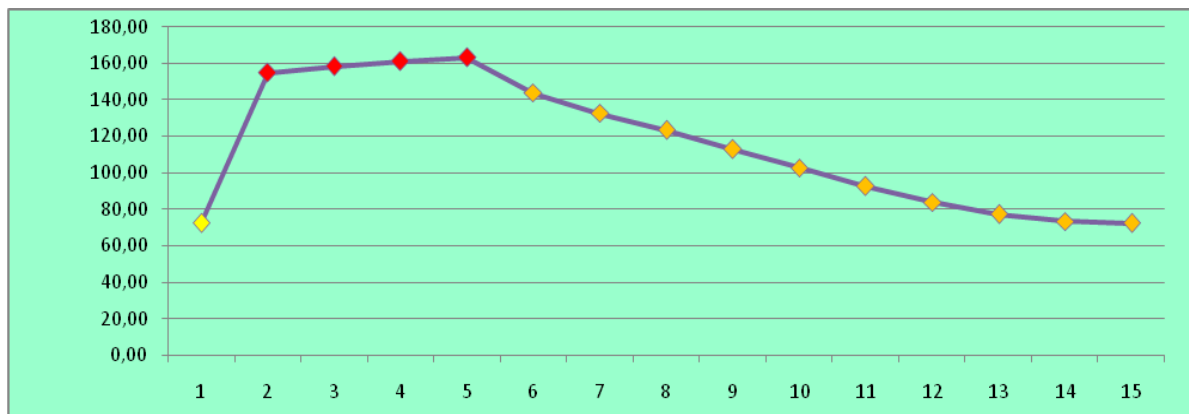
When dosing loads of strength and speed-strength nature, it is necessary to implement a differentiated approach, adequate to the preparedness of the athlete. For that purpose, we conducted a study in which an attempt was made to determine the level of development of

special endurance of freestyle wrestlers using standard physical load [4, 5, 6].

The data obtained in the course of the study made it possible to determine the degree of influence of a standard physical load of a strength and speed-strength nature upon the body, namely: the value of muscle tension as a percentage of the athlete's own body weight, the reaction of the body (cardiorespiratory system) to the standard load of wrestlers of various weight category and qualifications: heart rate at rest and after exercise, the speed of recovery processes after the standard metered load is completed - 24 dummy weighing 40 kg for 4 minutes with a frequency of 6 throws per minute.

Figure 2 shows the averaged heart rates of the wrestlers in the recovery period, which was recorded every 30 seconds by the intervalometry method (Uvarov V.A., Mrut

I.D., 1989) with further recalculation according to the Brouha method (L. Brouha, 1964).

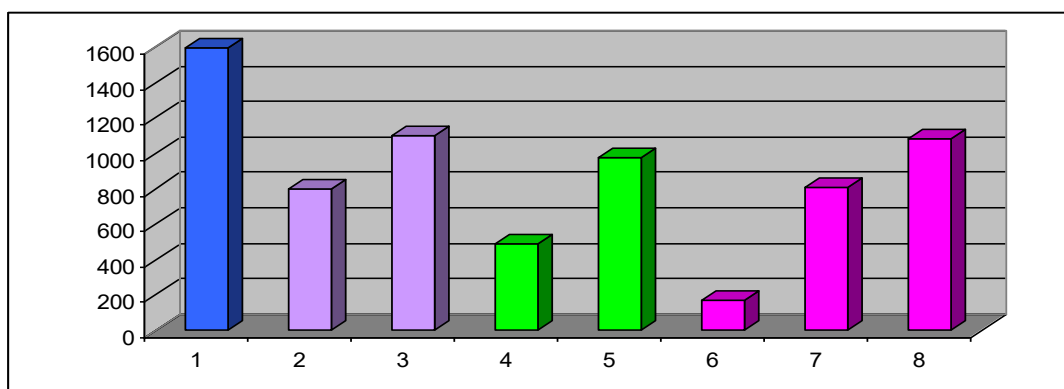


Symbols: 1, 2, 3, 4 15 - serial number of registration of heart rate during the execution of the standard metered load of a specific nature (1-4) and the recovery period (5-15)

Fig. 2. Dynamics of recovery processes when performing a standard metered load (average data)

The data presented in Table 1 clearly indicate that when determining the indicators of physical performance of athletes, the highest power of the performed load in the case of using the Harvard step test, which is in the range - from 1092 kgm / min for athletes in the weight category up to 57 kg, to 2457 kgm / min - for wrestlers weighing over 125 kg. This indicates that this method is very "difficult" for athletes of all weight categories. Unlike the Harvard step test, the bicycle ergometric

method (Karpman V.L., Belotserkovsky Z.B., Gudkov I.A., 1988) is the most "gentle" for athletes, in which the power of the dosed loads is in the range: the first load is only about 30.8% (for lightweights), and the second one - 61.5% (for athletes of the category over 125 kg) of the volume of work performed during the Harvard step test (Figure 3). At the same time, repeated physical activity, in its volume, differs significantly from the first (Figure 4).



Symbols: ■ - Harvard step test ; ■ - Step test (Karpman V.) ■ - Veloergometry; ■ - Wrestling dummy throws

Fig. 3. The volume of metered load (averaged data) when determining indicators of physical performance of wrestlers of various weight categories and wrestling styles

Table 1. Power of standard metered physical activity (average data) when determining PWC₁₇₀ indicators of wrestlers of various styles, expressed in kgm/min

Wrestling style	1		2		3		4		5		6		7		8		9		
	X	m	X	m	X	m	X	m	X	m	X	m	X	m	X	m	X	m	
Freestyle	< 57		57,1-61		61,1-65		65,1-70		70,1-74		74,1-86		86,1-97		97,1-125		>125		
Classic	< 59		59-66		66-71		71-75		75-80		80-85		85-95		95-130		>130		
Stat. characteristics																			
Average weight (kg)	56	0,3	59,5	0,3	63,5	0,4	68	0,2	72,5	0,5	80,5	0,1	92	1,1	111,5	2,2	126	0,9	
	58	0,3	63	0,2	69	0,5	73,5	0,4	78	0,2	83	0,4	90,5	0,9	113	1,9	131	1,2	
Harvard step test (kgm / min)	655	3,6	696	3,5	867	3,3	928	3,3	1131	3,3	1256	4,1	1615	4,7	1957	5,2	2457	6,3	
	1131	6,5	1228	7,8	1345	8,4	1433	6,5	1521	6,9	1618	4,7	1764	4,1	2203	7,5	2554	5,5	
Veloergometry (kgm / min)	336	2,1	357	2,2	381	2,1	408	2,4	435	2,4	483	2,9	552	3,3	669	2,7	756	5,3	
	348	1,3	378	1,9	414	3,2	441	3,6	468	3,4	498	3,7	543	2,7	678	3,3	786	3,0	
Step test (Karpman V.) (kgm / min)	672	3,3	714	3,4	762	3,8	816	4,4	870	3,6	966	4,8	1104	4,1	1338	3,8	1512	2,1	
	696	2,1	756	3,3	828	4,0	882	3,9	936	4,1	996	4,9	1086	4,4	1356	4,4	1572	5,4	
Throws (kgm / min)	546	3,1	580	3,3	722	2,7	774	3,6	943	4,4	1047	4,2	1346	6,1	1631	8,3	2048	7,7	
	660	2,2	717	3,4	897	4,4	956	5,2	1014	5,0	1079	4,9	1177	5,4	1469	6,6	1703	6,8	
	655	3,6	696	3,5	867	3,3	928	3,3	1131	3,3	1256	4,1	1615	7,9	1957	5,2	2457	6,3	
	791	2,9	860	4,4	1076	5,3	1147	3,9	1217	6,6	1295	3,8	1412	4,0	1763	6,8	2044	7,1	
	654	2,0	783	2,3	848	3,2	954	3,6	1025	3,5	1121	3,8	1243	4,0	1432	4,0	1595	3,9	
	737	2,1	803	2,4	918	3,3	987	2,9	1060	3,5	1137	3,6	1278	3,9	1494	3,7	1631	3,5	
	782	2,4	842	2,4	906	2,5	1013	2,5	1087	2,6	1185	7,5	1312	2,6	1508	2,7	1677	2,8	
	829	2,2	899	3,6	1018	5,7	1089	5,4	1166	6,6	1246	8,3	1347	5,5	1571	3,6	1771	4,4	

Continuation of Table 1.

Weight categories	Wrestling style	1		2		3		4		5		6		7		8		9	
		X	m	X	m	X	m	X	m	X	m	X	m	X	m	X	m	X	m
Average weight (kg)	Judo	59	0.2	64,5	0.2	70	0.3	77,5	0.3	86	0.2	95,5	0.4	101	0.4	-	-	-	-
	Sambo	51	0.2	55	0.2	60	0.3	65,5	0.3	71,5	0.3	78,5	0.2	86,5	0.4	95,5	1.1	101	1.3
Harvard step test (kgm min)	Judo	1150	3.3	1257	3.9	1365	4.2	1511	4.7	1677	5.8	1862	6.1	1969	6.6	-	-	-	-
	Sambo	994	3.1	1073	5.6	1170	7.7	1277	8.8	1394	9.2	1531	5.3	1687	5.0	1862	6.2	1970	8.0
Voloergometry (kgm min)	Judo	354	1.1	387	1.1	420	1.2	465	1.2	516	1.7	573	1.7	606	1.9	-	-	-	-
	Sambo	306	0.9	330	1.3	360	2.5	393	3.8	429	4.0	471	4.1	519	3.3	573	2.7	606	4.3
Step test (Karpman V.) (kgm min)	Judo	708	0.8	774	1.7	840	2.2	930	2.6	1032	2.9	1146	3.3	1212	3.5	-	-	-	-
	Sambo	612	1.9	660	4.7	720	6.8	786	5.1	858	5.0	942	5.3	1038	5.5	1146	8.9	1212	7.7
Step test (Karpman V.) (kgm min)	Judo	671	1.5	734	1.9	796	2.5	882	2.7	1118	4.2	1241	4.8	1313	5.1	-	-	-	-
	Sambo	497	1.1	625	2.8	683	3.9	745	4.1	813	4.9	1021	5.4	1125	4.7	1242	5.2	1313	6.6
Throws (kgm min)	Judo	805	2.4	880	2.5	955	2.8	1058	2.8	1341	3.1	1490	3.1	1575	3.2	-	-	-	-
	Sambo	597	2.1	751	3.7	819	6.0	894	4.2	976	5.8	1225	4.9	1349	5.0	1490	7.7	1576	6.9
Throws (kgm min)	Judo	902	2.3	991	2.4	1084	2.2	1181	2.6	1302	2.9	1415	3.8	1517	4.1	-	-	-	-
	Sambo	706	2.0	763	2.1	837	2.0	908	2.1	988	2.1	1075	3.1	1177	3.7	1292	-	1375	-
Throws (kgm min)	Judo	1007	2.3	1099	2.7	1195	2.9	1297	3.0	1421	3.3	1539	3.3	1608	3.8	-	-	-	-
	Sambo	783	1.9	842	3.3	921	6.1	995	4.8	1079	7.3	1170	8.5	1278	7.1	1399	5.5	1487	3.8

Figure 4 shows the ratio of volumes of standard metered physical activity when determining indicators of physical performance of wrestlers (various styles and weight categories), which clearly shows a large difference between the test loads performed, which manifests itself not only between different testing methods, but even when using only one method - veloergometry, where there is a big difference between the first and second test loads, and, with an increase in the weight category of athletes, so this difference becomes more apparent (in absolute values).

The results of this study are based on data from a systematic study of indicators of physical performance of sportsmen in the Central Research Institute laboratory CSI in FPES at the SUPES, and, starting since 2015, studies of the physical performance of women specializing in the freestyle wrestling, judo and sambo, This allowed the authors to perform also a number of special tests that contributed to improve the methodology for determining the physical performance of representatives of high-speed strength sports and clinical and physiological justification of a number of fundamental provisions on this issue (Table 2).

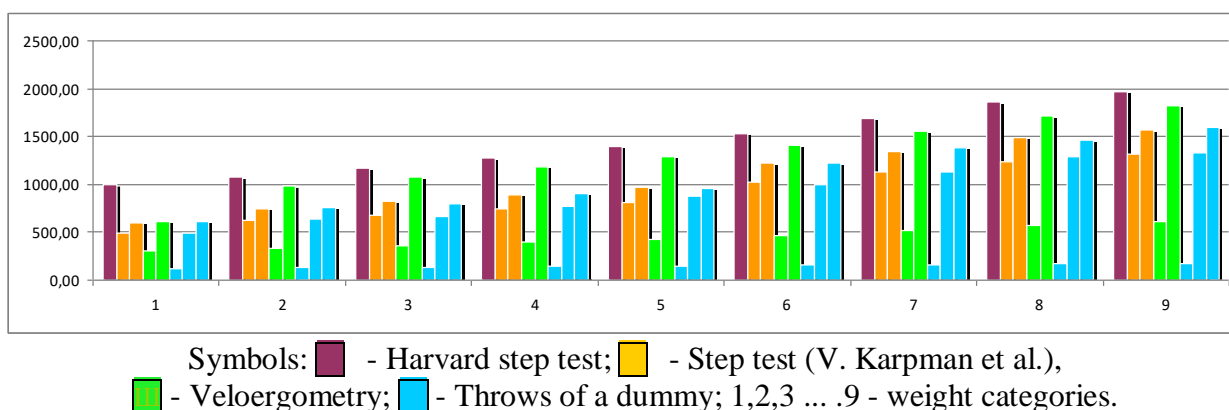


Fig. 4. The ratio of the volume of dosed physical activity when determining indicators of physical performance of wrestlers of various styles and weight categories (averaged data)

Indicators of physical performance, in our opinion, will have a high coefficient of reliability only if the following conditions are met:

- the speed of the movements (standing up of the wrestler, raising and installing the dummy, the wrestler occupying a comfortable starting position for the throw and the throw itself) should be kept relatively constant;

- the duration of each specific load should always be the same (for testing PWC₁₇₀ indicators - at least 4 minutes, so that the activity of the cardiovascular system reaches a steady state, and heart rate reach: at the end of the 1st load 110 - 130 beats / min, and in the end of the second - 150 - 160 beats / min with a mandatory 5-minute break between loads);

- Testing is preferably carried out at the same time of the day (preferably during an evening workout);

- the weight of the dummy must be standard or correspond to the weight category of the wrestler.

The data presented in Table 2, clearly demonstrate the ratio of the power of specific test loads (dummy throws) used in the study of indicators of physical performance of wrestlers, the research methods are highlighted in color (hatching), corresponding to each of them separately: Harvard step test - yellow, bicycle ergometric - green, power loads used in other methods.

Table 2. Power ratios (kgm / min) when using a standard metered load of a specific nature (throwing a dummy weighing 40 kg over the shoulder) and traditional methods for determining physical performance PWC₁₇₀ (on the example of freestyle wrestlers)

WEIGHT CATEGORIES		< 57	57-61	61-65	65-70	70-74	74-86	86-97	97-125	>125
Average weight (X)		56,3	60,1	64,5	68,2	73,3	81,7	92,0	112,2	126,1
Throws (cycles)										
4 min	1 min	1	2	3	4	5	6	7	8	9
4	1	146	150	154	159	164	172	184	205	220
6	1,5	218	224	231	239	246	259	276	307	330
8	2,0	291	299	308	318	328	345	368	409	440
9	2,25	327	337	347	358	369	388	414	460	495
10	2,5	364	374	386	398	410	431	461	512	550
11	2,75	400	411	424	437	451	474	507	563	605
12	3,00	437	449	463	477	492	517	553	614	660
13	3,25	473	486	501	517	533	560	599	665	715
14	3,50	509	524	540	557	574	603	645	716	770
15	3,75	546	561	578	596	615	647	691	767	825
16	4,00	582	598	617	636	656	690	737	818	880
17	4,25	618	636	655	676	697	733	783	870	935
18	4,50	65	5	673	694	716	738	776	829	921
19	4,75	691	7	10	732	755	779	818	874	971
20	5,00	728	748	771	795	821	862	921	1023	1100
21	5,25	764	785	810	8	35	862	905	967	1074
22	5,50	800	823	8	48	8	75	903	948	1013
23	5,75	837	860	88	7	914	9	44	991	1059
24	6,00	873	898	925	954	985	10	34	1105	1228
25	6,25	909	935	964	994	1026	1078	1151	1279	1375
26	6,50	946	972	1002	1034	1067	1121	1197	1330	1430
27	6,75	982	1010	1041	1073	1108	1164	1243	1381	1485
28	7,00	1019	1047	1079	1113	1149	1207	1289	1432	1540
29	7,25	1055	1085	1118	1153	1190	1250	1335	1483	1595
30	7,50	1091	1122	1157	1193	1231	1293	1382	1535	1650
31	7,75	1128	1159	1195	1232	1272	1336	1428	1586	1705
32	8,00	1164	1197	1234	1272	1313	1379	1474	16	37
33	8,25	1200	1234	1272	1312	1354	1422	1520	1688	1815
34	8,50	1237	1272	1311	1352	1395	1465	1566	1734	1870
35	8,75	1273	1309	1349	1391	1436	1509	1612	1785	1925
36	9,00	1310	1346	1388	1431	1477	1552	1658	1836	1980
37	9,25	1346	1384	1426	1471	1518	1595	1704	1887	2035
38	9,50	1382	1421	1465	1511	1559	1638	1750	19	38
39	9,75	1419	1459	1503	1550	1600	1681	1796	1989	2145
40	10,00	1455	1496	1542	1590	1641	1724	1842	2040	2200
41	10,25	1491	1533	1581	1630	1682	1767	1888	2091	2255
42	10,50	1528	1571	1619	1670	1723	1810	1934	2142	2310
43	10,75	1564	1608	1658	1709	1764	1853	1980	2193	2365
44	11,00	1601	1646	1696	1749	1805	1896	2026	2244	2420
45	11,25	1637	1683	1735	1789	1846	1940	2072	2295	2475

The following designations are used in the table: - Harvard step test; - Step test (V. Karpman et al.), - Veloergometry; - Throws of a dummy;

In this table, discrete values equal in power to the indicators obtained by various standard step-tests (V. Karpman et al.) are violet, and with throws, they are red. In accordance with the picture that appears in the table, it can be noted that the specific test loads used to determine physical performance are in the range between discrete values of the loads used in the standard step test - from 549 to 2035 kg / min (weight categories 57.1 - 125 kg) and, in part, in bicycle ergometry from 437 to 691 kgm / min (weight categories - <57 kg), which indicates that the methodology for determining the physical performance of wrestlers using specific loads (dummy throw) for freestyle wrestlers is quite acceptable and physiologically justified.

Conclusions. Based on the foregoing, the following conclusions can be drawn:

1. Throws of a dummy by deflection, over the back, over the shoulder or thigh, depending on the style of wrestling, can quite successfully be used in sports practice as both a specific test to determine the level of development of special physical training of wrestlers at various stages of training, and as a means of operational control for the development of a sportsman's sportswear with the possibility of making timely adjustments to the planning of sports training. At the same time, the data obtained during the testing process will help coaches and athletes to plan the means and methods of general and special

physical training, as well as competently build the tactics of the fight during sports competitions.

2. Specific loads (dummy throws), as our studies have shown, can be successfully applied to determine both absolute (kgm / min) and relative (number of throws per minute) indicators of physical performance PWC₁₇₀ wrestlers of various styles. The obtained results of our studies convincingly prove that, compared to other methods already widely used in sports practice, the method we offer with standard strictly metered test loads is more "sparing" for athletes, both in terms of the amount of work performed and the degree of reaction of the body - heart rate after exercise and the speed of recovery processes.

3. The methodology developed for determining indicators of physical performance using two standard strictly metered test loads is completely consistent with the opinion of the authors of previously developed classical methods (Karpman VL, Kots), who claim that it is more correct to determine indicators of physical performance of athletes will evaluate by two metered loads, and not by one. And this means that the test with determining the maximum number of throws for a certain period of time can only be used as an indicator of the development of special physical fitness and, in particular, special endurance of a wrestler.

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