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Research Article

FITNESS PROFILE OF JUNIOR JUDOISTS

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Abstract

Judo is a sport of variable intensity where high-intensity efforts vary with low-intensity activities. Judo is not only a technical-tactical preparation, but also a sport with requirements of a high level of functional and motor skills, which makes things complex enough. The aim of this research i to examine and determine motor-functional space in junior judoists. The sample of respondents consists of 66 male respondents of junior age, who were tested in three countries. The clubs that participated in the research are clubs from: Slovenia, Croatia and Bosnia and Herzegovina. The sample of variables used in SJFT (special judo fitness test) are: first 15 s - I, first 30s - II, second 30s - III, total number of throws - A, heart rate after test - HRa, heart rate after 1 min - HRb, SJFT index. Descriptive statistics and a paired t-test for dependent samples were used to process the data. Average values of the results obtained by the study for the total number of nage-komis (24.94; SD-2.14), heart rate immediately after the test (188; SD-8.8), heart rate after 1 minute (159; SD-13.6) and index (14; SD-1.5). These values refer to the 66 respondents of junior age participating in this test. The results of the research showed that all average results of variables can be classified as bad or very bad in the classification table, where the poor distribution of data is shown. If we looked at individual values, then 3% (maximum 2) of the total number of respondents (66) would have an excellent result, and 15% (up to 12 respondents) would have a good result on the total number of throws, while 45% of results (30) would rank under very bad. The average heart rate immediately after the test would be classified as bad, if the heart rate after 1 minute, or its average value could be classified as good. The average value of the index is in poor results. For the total number of throws we have 6 results that can be classified as good and excellent, for HR immediately after the test as many as 25 respondents are in the group of bad, while 11 respondents are very bad, which makes more than half of respondents. For HR 1 minute after the test, we have 30 subjects classified in the last two groups. Based on the obtained results, we can conclude that it is not impossible to include the results of juniors in the senior tables, but most of the results are classified as bad / very bad, which is the bottom of the classification table. However, there are differences between the body of seniors and juniors, so it would be necessary to separate the results of younger and older ages. The obtained results can be used as guidelines for more efficient programming of the training process, with special emphasis on age.

Keywords: Judo, Juniors, SJFT Test, Classification.

INTRODUCTION

Judo is an explosive sport that requires a high level of anaerobic capacity, due to frequent high-intensity stresses, but also well-developed aerobic endurance due to the efficient recovery process between consecutive matches. The goal of aerobic processes in judo is to prepare the working capacity of the heart and the ability of the heart to deliver oxygen to the muscles, which will improve the delivery of oxygen through continuous training, while interval training will increase the efficiency of oxygen utilization during combat. Judo belongs to the group of martial arts. For sports that belong to this group, it is characterized by a complex manifestation of all basic physical properties. Each judo fight lasts five minutes of pure time. Therefore, the work on the competition takes place somewhere on the border between the anaerobic (glycolytic) and mixed energy zones. That happens several times, because in the competition, each fighter usually participates in five fights, unless he goes to the rematch, where there are at most two more fights. All fights in one category are held during one day, which represents a great effort (Bratić, Nurkić and Stanković, 2011). Judo is often described as an explosive sport that requires great anaerobic strength and capacity, with a well-developed aerobic system. A high level of physical fitness and strength, with good fatigue tolerance, are necessary prerequisites for competitive success since judo is characterized by alternating activities of maximum intensity of 15-30s and rest of about 10s (Sterkowich and Franchini, 2000). The functional abilities of judoists, and especially aerobic ones, are extremely emphasized due to the large expenditure of energy during one fight, which lasts for five minutes without interruption. Due to the continuous load, which alternates between the engagement of aerobic and anaerobic mechanisms of the organism, the judoist undergoes a specific training process to increase functional abilities. Judo competitions are mostly of the tournament type and competitors have a larger number of fights in one day (Bratić *et al.,* 2007). In judoists, as in other athletes, body weight and the percentage of adipose tissue have a negative impact on the values of maximum oxygen consumption. It is believed that a lower percentage of adipose tissue allows top judoists better metabolic adaptation to different technical and tactical requirements during the match (Franchini *et al.,* 2005). Judo was commonly described as a martial art, a spiritual discipline, a system of physical education and recreational activity. Judo literally means “the way of gentleness”, precisely a dynamic combat sport that requires both physical prowess and great mental discipline (Peset *et al.,* 2013). Judo wrestling consists of a work period of 20-30 seconds and a rest period of 5-15 seconds (Sterkowicz and Franchini, 2009). Considering this ratio, 2: 1, it can be concluded that the demand for energy capacity for oxygen will increase as the fight nears its end and the ability to sustain high-intensity work actions will decrease. So judo is not only a technical-tactical preparation but also a sport with

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requirements of a high level of functional and motor skills, which makes things complex enough. As judo martial arts is a sport of high intensity with acyclic characteristics of medium duration and taking into account the multi-hour competition process, there is a need to test judo fighters to evaluate their abilities and investigate the reasons for their effectiveness in the competitive part of the sport. In his search for a specific test that will give concrete results, Sterkowicz (1995) recommended a high-intensity test (SJFT-Specific Judo Fitness Test), which uses the ippon-seoi-nage technique. Since 1995 when the test was created until today, hundreds of studies in judo have been conducted using SJFT at different ages, training levels, both genders, etc., but specific results have been defined only for seniors, male competition of all categories, by (Sterkowicz and Franchini, 2009), while women and younger people cannot be adequately included in the table for the classification of results where the results are classified as bad and very bad. In a study (Sterkowicz and Franchini, 2009), the authors noted the need to compile classification tables for women and for all weight categories separately. SJFT is a very useful tool in sports that can identify an individual and his current level, compare with previous or include in future research, and just as it can serve the purpose of assessing the condition of athletes can serve in rehabilitation, the coach can compare results with those before injuries, etc. For now, the SJFT has proven to be accurate in distinguishing judo fighters of different levels, confirms Sterkowicz (1996), who found that the Polish national team in 1994 had better results than judoists with lower results. In another study (Sterkowicz and Franchini, 2001) with 80 subjects divided into two categories under and over 21, they found a significant difference in heart rate 1 minute after the test and in the index, in favor of the older group. After that, the same groups were divided into 2 new groups per kilogram, above and below 81 kg, where the number of throws and the index were statistically significant in favor of the lighter group. The sport is characteristic for its short duration high intensity activity, which makes it an anaerobic sport. Competitive success in judo depends on a number of factors, which include functional abilities. The control of competitive and training loads is becoming more accurate and it provides significant information for the coaches (Koprivica, 2018). The fact that there are significant links between the functional characteristics and the technical elements in judo implies that the improvement of specific functional abilities can influence the performance of techniques during training and competitions. Todorov *et al.* state that enhanced anaerobic capacity with reduced quantities of body fat allow the performance of a large number of actions during combat, while high values of aerobic capacity accelerate the recovery process between fights (Todorov *et al.,* 2013).

MATERIAL AND METHODS

Participants

The sample of respondents in this study has an age group as the main characteristic of all respondents, and these are juniors aged 16-21 with the exception of a couple of boys who were cadets but are competitors at the junior level. The sample of respondents consists of 66 junior respondents who were tested in three countries. All respondents who have been tested have a minimum of 3 years and a maximum of 10 years of training experience and are winners of national medals or winners of 5th place in the same competition, all respondents competed in at least one European Cup in cadets and juniors, while regularly performing in international competitions. Judo Club "Una", in cooperation with friendly clubs from the area, and through friendly trainings and training camps, helped the authors in collecting that data. The clubs that participated in the research are as follows: Slovenia (JK Zdežele) 10 respondents, Croatia (JK Rijeka, JK Labin, Dalmatia cement, JK Dubrava, JK Solin, JK Osjek, JK Panda, JK Pujanke) 20 respondents and from Bosnia and Herzegovina (JK Bosnia, Famos, JK Lukavac, JK Una, JK Zvijezda) 36 respondents.

The sample of variables

The sample of variables used in the SJFT (special judo fitness test) are: The first 15s - I; The first 30s - II; Other 30s - III; Total number of throws - A; Heart rate after test - HRa; Heart rate after 1 min - HRb; Index SJFT - Index.

Research Desing

SJFT (Figure 1) is divided into three periods: 15s (I), 30s (II), 30s (III) with rest intervals of 10 seconds in between. During each period, the tori (the one doing the test) throws two partners (uke A and B) who are 6 meters apart as many times as he can on the ippon-seoi-nage technique (manual throw).

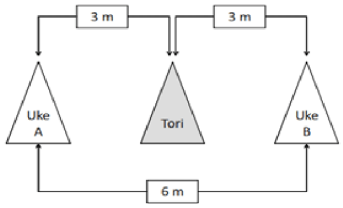

Figure 1. SJFT scheme
(Sterkowicz, 1995)

Uke A and uke B should be the same height and weight as the tori. The pulse is measured immediately (HR) and 1 minute after the end of the test (HR1min). The ability to perform a large number of throws in this short period is mostly associated with anaerobic capacity, while the recovery of heart rate (pulse) is associated with aerobic capacity. And the SJFT index is calculated by dividing the pulse by the number of throws (Equation 1).

$$index = \frac{\text{HR} + \text{HR1min}}{\text{ukupni broj bacanja}}$$

Equation 1. The calculation of SJFT index

A lower index represents a better result in this test. Performance in this test can be improved by increasing the number of throws, which would mean an increase in anaerobic power. By lowering HR at the end of the test which would mean improvement in the cardiovascular system and lowering HR 1 minute after the test which would refer to improving aerobic power. The choice of ippon-seoi-nage technique was chosen for two reasons, under one this technique requires only one hand to perform and immediately prepare the tori to run to the other side, under two its representation in competitions.

Statistical Analaysis

Descriptive statistics and a paired t-test for dependent samples were used to process the data. The statistical program for personal computers SPSS for Windows version 22 was used for data processing. The level of inference was set to $p < 0.05$.

RESULTS

Table 1 describes te general data on the respondents, the most important variable is Mean, which will later be used in comparison with the senior classification table (Franchiniet al., 2009).

Table 1. Statistical report on the frequency of research results

		A	HRa	HRb	INDEX	Age
N	Valid	66	66	66	66	66
	Missing	0	0	0	0	0
Mean		24.94	188.18	159.71	14.0136	17.73
Std. Error of Mean		.263	1.094	1.676	.19236	.162
Median		25.00	190.00	160.00	14.0550	18.00
Mode		24	192	150a	11.92a	18
Std. Deviation		2.140	8.885	13.612	1.56273	1.319
Variance		4.581	78.951	185.285	2.442	1.740
Skewness		.052	-.721	-.032	.155	.193
Std. Error of Skewness		.295	.295	.295	.295	.295
Kurtosis		-.385	-.117	-.406	-.697	-.326
Std. Error of Kurtosis		.582	.582	.582	.582	.582
Range		10	35	60	6.31	6
Minimum		20	168	132	11.21	15
Maximum		30	203	192	17.52	21

Table 2 describes the relationships in two groups divided by weight. The first group -81 kg (a) and the second group +81 kg (b) show slight deviations.

Table 2. Differences in categorical groups

Statistics of paired variables					
		Mean	N	Std. Deviation	Std. Error Mean
Par 1	a	24.83	30	2.135	.390
	b	25.40	30	2.159	.394
Par 2	hra	190.87	30	6.606	1.206
	hraa	187.53	30	8.943	1.633
Par 3	hr1	161.77	30	12.328	2.251
	hr1b	161.40	30	13.200	2.410
Par 4	index	14.29	30	1.46134	.26680
	indexb	13.77	30	1.73437	.31665

Table 3 decribes the relations between the three groups, divided according to nationality.

Table 3.Comparison of results by nationality

Statistics of paired variables					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	abih	24.20	10	1.814	.573
	aslo	25.50	10	2.014	.637
Pair 2	hrbih	192.60	10	8.329	2.634
	hrslo	181.50	10	8.835	2.794
Pair 3	hr1bih	167.60	10	14.623	4.624
	hr1slo	154.00	10	14.166	4.480
Pair 4	indbih	14.92	10	1.02271	.32341
	indslo	13.27	10	1.84931	.58480
Pair 5	abih	25.12	26	2.123	.416
	ahr	24.38	26	2.210	.434
Pair 6	hrbih	191.73	26	6.096	1.196
	hrhr	186.58	26	10.144	1.989
Pair 7	hr1bih	163.23	26	13.186	2.586
	hr1hr	158.19	26	14.218	2.788
Pair 8	indbih	14.15	26	1.53975	.30197
	indhr	14.21	26	1.53854	.30173
Pair 9	aslo	25.50	10	2.014	.637
	ahr	24.80	10	2.530	.800
Pair 10	hrslo	181.50	10	8.835	2.794
	hrhr	189.00	10	8.641	2.733
Pair 11	hr1slo	154.00	10	14.166	4.480
	hr1hr	167.30	10	12.120	3.833
Pair 12	indslo	13.27	10	1.84931	.58480
	indhr	14.42	10	1.73135	.54750

DISCUSSION

Average values of the results obtained by the study for the total number of naga-komis (24.94; SD-2.14), heart rate immediately after the test (188; SD-8.8), heart rate after 1 minute (159; SD-13.6) and index (14; SD-1.5) were calculated for the purpose of classification in the classification table (Table 6).

Table 4. Paired T-test for weight groups

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	a – aa	-.567	2.501	.457	-1.500	.367	-1.24	29	.225
Pair 2	hra–hraa	3.333	12.713	2.321	-1.414	8.080	1.436	29	.162
Pair 3	hrb–hrbb	.367	21.929	4.004	-7.822	8.555	.092	29	.928
Pair 4	index - indexb	.526	2.33288	.42592	-.34511	1.39711	1.235	29	.227

Table 5.Paired T-test for representative groups

Paired T-test, national teams									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error	Mean	95% Confidence Interval of the Difference			
						Lower	Upper			
Pair 1	abih - aslo	-1.300	2.584	.817		-3.149	.549	-1.59	9	.146
Pair 2	hrbih - hrslo	11.100	12.714	4.021		2.005	20.195	2.761	9	.022
Pair 3	hr1bih - hr1slo	13.600	23.801	7.527		-3.426	30.626	1.807	9	.104
Pair 4	indbih - indslo	1.64800	2.16517	.68469		.09913	3.19687	2.407	9	.039
Pair 5	abih - ahr	.731	2.554	.501		-.301	1.762	1.459	25	.157
Pair 6	hrbih - hrhr	5.154	11.051	2.167		.690	9.618	2.378	25	.025
Pair 7	hr1bih - hr1hr	5.038	18.996	3.725		-2.634	12.711	1.352	25	.188
Pair 8	indbih - indhr	-.05192	2.16909	.42539		-.9280	.82419	-.122	25	.904
Pair 9	aslo - ahr	.700	3.129	.989		-1.538	2.938	.708	9	.497
Pair 10	hrslo - hrhr	-7.500	13.575	4.293		-17.21	2.211	-1.74	9	.115
Pair 11	hr1slo - hr1hr	-13.300	14.553	4.602		-23.71	-2.889	-2.89	9	.018
Pair 12	indslo - indhr	-1.1450	2.46655	.77999		-2.909	.61946	-1.46	9	.176

Table 6. Classification table for seniors (Franchini *et al.*, 2009)

Classification	Variables			
	Total of throws	HR after (bpm)	HR 1min after (bpm)	Index
Excelent	≥29	≤173	≤143	≤11.73
Good	27–28	174–184	144–161	11.74–13.03
Average	26	185–187	162–165	13.04–13.94
Poor	25	188–195	166–174	13.95–14.84
Very Poor	≤24	≥196	≥175	≥14.85

The results of the research showed that all average results of variables can be classified as bad or very bad in the classification table. If we looked at individual values, then 3% (maximum 2) of the total number of respondents (66) would have an excellent result, and 15% (up to 12 respondents) would have a good result on the total number of throws, while 45% of results (30) would rank under very bad. The average heart rate immediately after the test would be classified as bad, while the heart rate after 1 minute, or its average value could be classified as good. The average value of the index is in poor results (14). In Table 2, where the groups were determined by categories, there were no statistically significant differences in the results (Table 4), which coincides with other studies (Franchini *et al.,* 2001; Franchini *et al.,* 2009). In Table 3, fighters from Slovenia achieved the best results, but given the significantly smaller number of respondents from Slovenia (10) compared to the other two groups (26) we cannot take the results for sure. Sterkowicz and Franchini (2001) investigated the differences between Polish medal winners and non-Polish judoists, where better results were achieved by medal winners in all SJFT areas. The paired t-test (Table 5) did not show statistical significance for the results probably for the reason already mentioned, lack of results for one of the 3 groups.

Judo belongs to the group of polystructural acyclic sports in which acyclic movements dominate (Kajmović, 2009; according to Crnogorac and Mekić, 2012), which means that we can describe it as an activity of special complexity. In the structure of complexity, it is difficult to compare it in a simplified way with other and different activities (Rađo, 2003; according to Crnogorac and Mekić, 2012), and it is certain that there is an opponent, and that the goal is to bring it to symbolic destruction. The fight lasts five minutes. However, during the allowed time, there are many interruptions during the fight. A typical time structure is 30s of activity with 10s of downtime. There is an average of twelve such segments. The most common breaks between fights during eliminations last about 30 minutes. Various techniques in judo complicate the structure of the fight itself and require timely execution of the technique as well as its individual phases using the full potential of the fighter who is able to apply technical and tactical stereotypes he has adopted, and currently reorganizes them in terms of attack, defensive and counter-offensive action programs. Competitive judo can be described as a high-intensity martial art in which a judoist tries to throw an opponent on his back or control him while fighting in the ground floor. Both activities depend on specific techniques and tactical skills supported by good physical fitness. There is a connection of methodological importance between strength, speed and endurance. During the initial years of training, skills must be developed to build a solid foundation for specialized training. In top athletes, the relationship between magnitude for maximum speed and endurance, as the most determined biomotor skills that are difficult to develop, will depend on the characteristics of the sport and the needs of the athlete (Franchini *et al.,* 2005). In sports training, there is often more interest in improving the athlete through his physiological components, known as motor skills, than through the mere improvement of movement. Most movements include elements of force, speed, duration, complexity and radius of movement to a certain limit. Furthermore, individual motor aspects can be studied, such as strength, speed, endurance and coordination (Crnogorac and Mekić, 2012). Physiological requirements of this form burden both the aerobic and anaerobic systems. The anaerobic system provides short, fast and explosive outbursts of maximum strength during the match, while the aerobic system contributes to the ability of the judoist to withstand the effort during the fight and to recover during short periods of rest or reduced effort. The most significant presented correlations show that athletes from heavier categories are stronger in the absolute sense (Crnogorac and Mekić, 2012). However, there was a negative correlation between weight and SJFT performance, showing that heavier athletes have lower aerobic capacity in activities involving throwing opponents of the same category. The poorer results of heavier athletes in the Cooper test can be derived (explained) by the correlation between weight and estimated VO2max. Much of this relationship can be explained by the high percentage of fat and low performance. The negative impact of body fat on motor characteristics has been found in some studies. Nakajima and colleagues found a negative effect of body fat on isometric strength, flexibility, balance and aerobic capacity in female judoists. The previous study also presented a negative correlation between the percentage of body fat and the number of throws in SJFT (r = 0.70) and between the percentage of body fat and the number of attacks in combat simulation (r = 0.76) in high-level universal judoists (Franchini *et al.,* 2005). Kapo *et al.* (2015) proved the benefit of SJFT as a tool for detecting asymmetry in the movement of judoists (when performed in both directions) and the importance of bilateral development of judoists. The sample of respondents included 9 respondents (men) aged 13-14, the testing procedure was performed according to the standard sample of SJFT. Based on the obtained results, it was concluded that much larger groups of respondents are needed in order to create better standards that will enable optimal development of technologies. Franchini *et al.* (2005) performed testing of 13 elite judoists on SJFT, wingate test and combat simulation. The results show that the results of the wingate test, the number of throws in the SJFT and the attacks in the combat simulation are inversely proportional to the percentage of fat. Based on that, it was proved in the conclusion that manual techniques are highly related to blood lactates measured after the simulation, pointing to higher psychological requirements for this type of technique. Katarzyna *et al.* (2010), conducted a study on 8 juniors using SJFT, doing an analysis of 10 muscle groups, test of maximum strength, jump height, etc. For the purpose of comparing biomechanical and specific methods of controlling the process of judo training. In conclusion, training is a process in which all testing methods should be used for self-discipline, constant measurements give us a sense of optimal training control. Katralli and Goudar (2012), Indian scientists who conducted a study of the training of Indian judoists. Although they are familiar with the current position of judo in India, due to unfamiliarness of the population with judo, it is quite neglected. Despite this situation, the scientists investigated the relationship between the SJFT index, the volume of 7 antopometric points, weight, height, and the percentage of fat between 2 groups of respondents. One group consists of 20 judoists who train for 5<years, and the other consists of 11 respondents with training experience <5 years. The main

conclusion of the research is that the difference in the length of training experience is negligible in the obtained results. There is a negative correlation between fat percentage and performance. Casalas *et al.* (2017), conducted research on anthropometric variables affecting SJFT. 51 respondents (of which 29 women) of the Spanish national team were tested during the competition period. Body weight, sex, skin fold of the biceps, and muscular structure are considered to have the greatest degree of deviation in the results. In their research, Drid *et al.* (2015) examined anthropometric measures and fitness profiles of European light heavyweight judoists. On a sample of 10 respondents, 5 holders of national and 5 international medals, testing was performed for 4 days. They tested forearm strength, long jump, high jump, medical throw, push-ups, deadlifts, bench press and deep squats. The results of the international medal winners were superior to the national ones, although the international ones had a higher mass of muscular extremities, the results showed a similar percentage of fat.

Conclusion

Based on the obtained results, we can conclude that it is not impossible to include the results of juniors in the senior tables, but most of the results are classified as bad / very bad, which is the bottom of the classification table. However, there are differences between the body of seniors and juniors, so it would be necessary to separate the results of younger and older ages. SJFT is known to be a reliable tool for detecting progress or still for discrimination against athletes of different levels. The aim of this paper was to determine this adequacy in the application of the results of younger age at SJFT. For the purpose of this research, 66 respondents, men up to 21 years of age, were examined, where the following results were obtained:

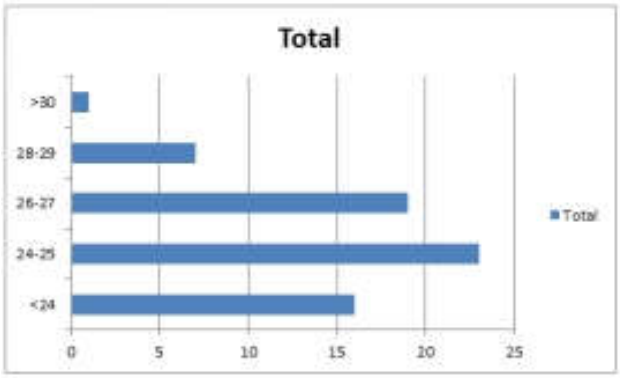

Figure 2.Total number of throws

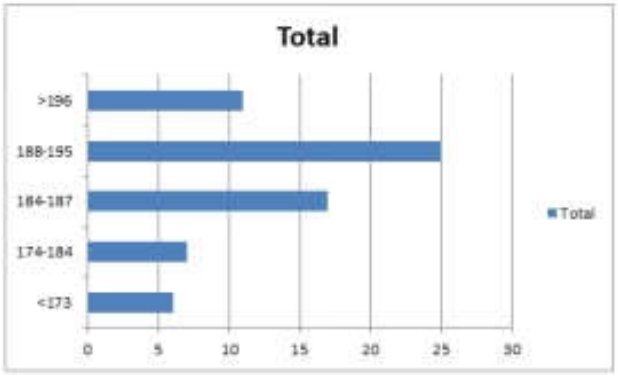

Figure3. HR immediately after the test

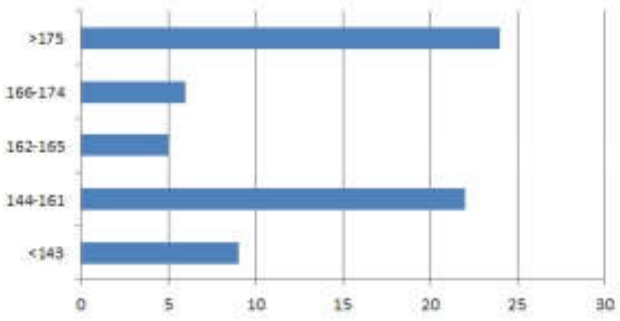

Figure 4. HR 1 minuteafter the test

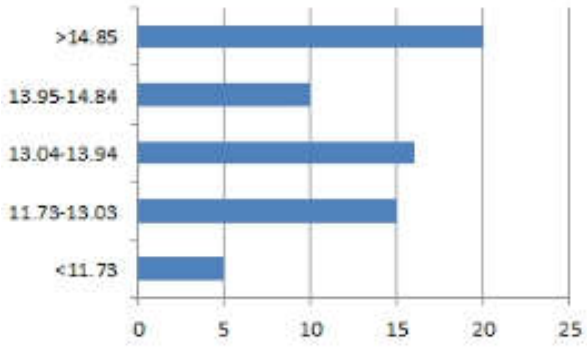

Figure 5. Index SJFT

According to the figures above, a negative ratio of results can be noticed, for the total number of throws we have 6 results that can be included in good and excellent (Figure 5), for HR immediately after the test as many as 25 respondents are in the bad group, while 11 respondents are very bad, which makes up more than half of the respondents (Figure 6), for HR 1 minute after the test we have 30 respondents classified in the last two groups (Figure 4). Analyzing the work, results and the last 4 figures (Figure 2, 3, 4, 5) we get evidence that it is not impossible to include junior results in senior tables, but most results are classified as bad / very bad, which is the bottom of the classification table. However, there are differences between the body of seniors and juniors, so it would be necessary to separate the results of younger and older ages. Therefore, we can conclude that a new classification table for juniors is needed (Table 7). The table was modeled on Franchina, 2009, after analysis, by dividing the data into 5 corresponding groups (20% of each category).

Table 7. Author's classification table for juniors

Classification	Variables			
	Number of throws	HR after	HR 1 minuteafter	Index
Excellent	27≤	≤176	≤144	≤12.80
Very good	26-27	177-184	145-156	12.81-14.40
Good	24-25	185-192	157-168	14.41-16.00
Bad	22-23	193-200	169-180	16.01-17.60
Very bad	≤21	201≤	181≤	17.61≤

In juniors, SJFT did not show statistically significant results in the domain of weight categories. In the analysis of the data, they did not show statistically significant deviations in the groups divided by categories. There are no statistically significant differences between the teams paired with the T-test. The reason for such results is found in the uneven number of respondents from different countries.

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