

Differences in technical and tactical training of the world's leading national teams in judo tournaments in 2017-2018

Authors' Contribution:

- A Study Design
- B Data Collection
- C Statistical Analysis
- D Manuscript Preparation
- E Funds Collection

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Abstract

Background and Study Aim:

World-level judo athletes are characterized by a high level of technical-tactical skills. The purpose of this study was knowledge of the probable differences in the technical-tactical training of judo athletes of the Japanese, Georgian and French national teams.

Material and Methods:

The research material consisted of audio-video recordings of IJF senior international competitions from 2017-2018. The fight recordings can be found in the collection of multimedia files on the websites www.judobase.ijf.org and www.dartfish.tv. The course of the fights was analysed by a high-class judo coach with many years of coaching and competition experience. Total 1769 fights were studied, 4010 technical actions and 1976 penalties were recorded. The following were evaluated: the technical actions used, the activity in attack and the proportions of their components, as well as the effectiveness of the actions.

Results:

It was found that Japanese competitors showed the highest activity during fights. A weak correlation was found between national team membership and the frequency of effective attacks, ineffective attacks and forced penalties during the fight. In contrast, this relationship at a moderate level was noted in the first part of the fight. When comparing the techniques used, a moderate statistically significant relationship was found between the affiliation of the national teams studied and: classification taking into account torso rotations, Kodokan classification and method of attack application. A weak one between the affiliation of the studied national teams and the side of the lean with which the attack was combined. Georgia competitors had the highest average referee's scores. It was statistically significantly different from the marks received by the French representatives. Statistically significant differences between the effectiveness of the actions of the competitors of the studied national teams also occurred in the following areas: throws with a rotation of the torso, throws without a rotation of the torso, hand throws, sacrifice techniques, single attacks, forward direction of the attack, throws applied to the right, the first part of the fight and the second part of the fight.

Conclusions:

The characteristics of the technical-tactical training of the studied teams, as determined in the study, should be used as models in planning the formation of the competitor's technical-tactical training. They can also be used by coaches of national teams preparing judokas for confrontation with competitors of the studied teams.

Keywords:

competition experience • effective attack • Kodokan division

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IJF – International Judo Federation.

Judo – a combat sport created in Japan by Jigorō Kanō from the martial art of jūjutsu. The standards of judo marked the development of other Japanese combat sports. Olympic competition takes place according to the rules of the International Judo Federation [20].

Judo – *noun* a Japanese martial art in which opponents use balance and body weight, with minimal physical effort, to throw each other or hold each other in a lock [21].

Tactics – *plural noun* the art of finding and implementing means to achieve immediate or short-term aims [21].

Technique – *noun* a way of performing an action [21].

Waza – a technique or movement which is based on a standard form and is used to challenge and defeat the opponent [22].

Ashi-waza – foot throwing techniques.

Nage-waza – judo throwing technique.

Te-waza – hand throwing techniques.

INTRODUCTION

Combat sports are customarily referred to as a group of those sports whose essence of competition is a direct clash between two athletes. The sporting value of an athlete (in addition to a specific profile of psychological predispositions) is a resultant of technical skills, the level of motor skills (strength, speed and endurance) and tactical skills that in most cases perform, in relation to these components, an overriding function [1].

In order to rationally plan training, it is first necessary to determine the model of competition, that is, the demands placed on athletes by the sporting struggle. Due to the fact that this model is evolving (influenced, for example, by changes in regulations), it should be constantly updated. Hence, authors often deal with this problem in scientific publications. Studies address the techniques used [2-6] the activity and effectiveness of actions [7-9], or the temporal structure [10].

As the athletes' sports level increases, individualization becomes increasingly important. At its core is the existence of a relationship between technical and tactical training and the somatic constitution [11] and the level of motor performance of athletes [12, 13]. The way in which direct opponents fight is also important, especially in the run-up to sports competitions.

It also seems interesting for the theory and practice of training to determine the way the world's top athletes conduct their fights. On this basis, we can determine the indicators of technical-tactical training conditioning the achievement of sports success. It also creates the opportunity to better prepare athletes for direct confrontation with representatives of the analysed teams.

So far, few authors have dealt with a comparative analysis of the way the world's leading athletes conduct their fights. Among the researchers interested in this issue, we can mention Adam and Sterkowicz-Przybycień [9], who, based on the observation of fights at three consecutive world championships, made a comparison of the technical-tactical training of judokas from Japan and Russia.

The purpose of this study was knowledge of the probable differences in the technical-tactical training of judo athletes of the Japanese, Georgian and French national teams.

MATERIAL AND METHODS

The research material was an audio-video recording of IJF World Tour competitions covering a two-year cycle of senior competition. The fight recordings can be found in a collection of media files at www.judobase.ijf.org and www.dartfish.tv.

The analysed fight recordings came from 28 tournaments held during the 2017 and 2018 World Championships, as well as Grand Slam and Grand Prix competitions organized by the IJF in 2017-2018. The actions of 202 athletes from the world's top three national teams, Japan (67 judokas), Georgia (68 judokas) and France (67 judokas), fighting in 7 weight categories (60kg, 66kg, 73kg, 81kg, 90kg, 100kg, +100kg), were observed. A total of 1769 actions were analysed. There were 4010 technical actions (including 2654 ineffective and 1356 effective) and 1976 forced penalties on the opponent, a total of 5986 actions.

Analysing individual tournament bouts, the techniques used by individual players and the penalties received were recorded in Microsoft EXCEL. The database created was copied to the STATISTICA PL program, in which most of the analysis was carried out.

In the first step, the reliability of the observations was checked. The correlation coefficient between different observers (high-level judo coaches) for WA (activity index) was 0.997; 95% CI (confidence interval): 0.991-0.999, for WS (efficiency index) was 0.9579; CI: 0.852-0.9884. The intra-class correlation coefficient (ICC) for the same observer for WA was 0.998; CI: 0.993-0.999, for WS: 0.989; CI: 0.961-0.997. The standard error of measurement (SEM) for the same observer for WA and WS was 1.5% and 1.9%, respectively. The above results indicate high reliability of the observations.

The subject of the study was statistically processed to determine the technical-tactical training of the players. It included an analysis of the players' activity in attack, the proportion of its components and the effectiveness of the activities. In the evaluation of activity, the activity index, calculated using the formula, was used:

$$\text{Activity index (WA)} = \frac{\sum A}{NW}$$

where:

$\sum A$ – sum of activities - effective attacks applied, ineffective attacks and penalties forced on the opponent. An attack was classified as ineffective if there was an apparent loss of balance combined with a fall, and the judges did not award points for this action; NW - the number of fights fought by each competitor. The activity index (WA) synthesized information on the number of effective attacks, ineffective attacks and forced penalties on the opponent

Analysing the components of activity, the distributions of the number of effective attacks, ineffective attacks and enforced penalties were compared. A score of 0.5 was considered a significant difference in WA values, and a score of more than 1 per fight was considered large.

The efficiency index is the arithmetic average (\bar{X}) of the referee ratings of the technical actions recorded, expressed by the following formula:

$$\text{Efficiency index (WS)} =$$

$$\frac{\text{sum of points received}}{\text{number of performed effective and ineffective technical actions}}$$

To deepen the analysis, the noted techniques were divided according to the following criteria:

- the occurrence of rotations around the long axis of the body (with or without rotation);
- Kodokan classifications (hand throws, foot throws, hip throws, sacrifices and actions used in ground fighting);
- modes of attack application (single attacks, combinations, counter attacks);
- direction of attacks (front, back);

- the side of the opponent's lean with which the attack was combined (right or left);
- the time of the action (the 1st part of the fight, i.e. minutes one and two, and the 2nd part of the fight, i.e. the third and fourth minutes of the fight plus overtime).

In terms of the above divisions, the effectiveness of measures was analysed and frequency distributions were compared. In describing the research material, multidivisional tables were used. To compare the frequency distributions of classified actions used in combat, the Chi² trait independence test was used. The strength of the relationship was determined using Pearson's corrected coefficient of convergence Ckor.

In interpreting the coefficient of convergence C, the following value limits were adopted:

- C less than 0.1: weak dependence;
- C greater than or equal to 0.1 and less than 0.3: moderate dependence,
- C greater than or equal to 0.3: strong dependence.

In the case of performance comparisons, it was found that in all cases analysed, the variables do not have a normal distribution. The Kolmogorov-Smirnov test was used to test normality. Thus, the analysis used the Mann-Whitney U test and the non-parametric equivalent of variance (Kruskal-Wallis H test and Mann-Whitney U test). For multiple comparisons, the Mann-Whitney U test used the Bonferroni correction, which involves dividing the significance level of $p = 0.05$ by the number of comparisons.

RESULTS

The competitors from Japan showed the highest activity during the fight. There was a large difference in the value of WA between the athletes from Japan (3.99) and France (2.89), and a significant difference between the representatives from Japan and Georgia (3.11). Analysing this indicator in individual fragments of the fight, its significant difference was noted in the first two minutes of the competition between judokas from Japan (WA1 = 1.84;) and France (WA1 = 1.34;). This

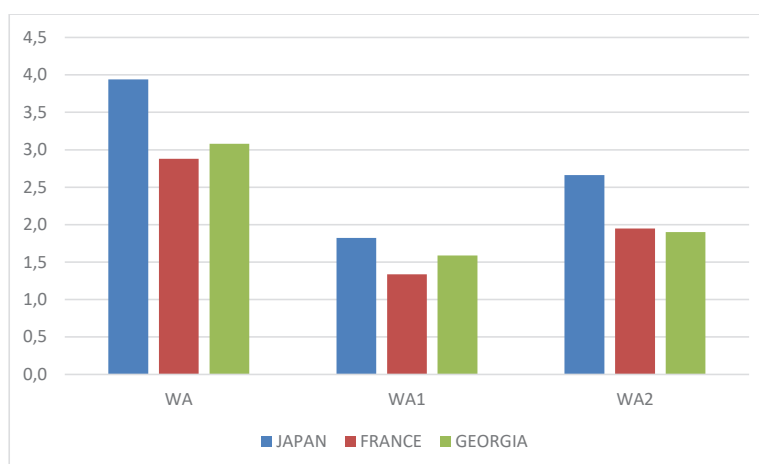


Figure 1. Activity index values in judo fight and its specific parts: **WA** activity index; **WA1** activity index for the first two minutes of the fight; **WA2** activity index for the subsequent minutes of the fight.

regularity was also true for the subsequent minutes of the fight (WA2 = 2.69 and WA2 = 1.98, respectively). In addition, a significant difference in the studied indicator was also visible between the Japanese and Georgian teams in the second part of the confrontation (Figure 1).

Based on statistical analysis (Table 1), there was a weak relationship ($C_{kor} = 0.075$) between national team affiliation and the frequency of effective, ineffective attacks and forced penalties. It consisted of the fact that ineffective attacks were more often performed by competitors from France and Japan, while effective attacks were performed by competitors from Georgia. The lowest frequency of effective attacks was demonstrated by judokas from France, who at the same

time forced penalties on their opponent most often out of the compared groups. Taking into account the listed fragments of the fight, a moderate relationship between the frequency of the use of effective, ineffective and provoked penalty attacks and national team membership was noted in the second part of the fight. It consisted in the fact that the competitors from Japan were characterized by the highest frequency in ineffective attacks, the representatives from Georgia in effective attacks, and the French judokas most often forced penalties on their opponents.

Comparing the techniques used in the observed judokas (Table 2), a moderate statistically significant relationship was found between the membership of the representations studied and:

Table 1. Proportion of tactical actions during consecutive minutes of competition in a group of competitors from Japan, Georgia and France.

Part of the fight & total fight	Compared groups competitors												Values characterizing differences between groups	
	Japanese				Georgian				French				Test value, significance level	Strength of relationship
EA	IA	PE	Total	EA	IA	PE	Total	EA	IA	PE	Total			
1 part	540	250	436	1226	423	234	384	1041	288	105	219	612	$\chi^2=9.467526$ $p>0.05$	
%	44.05	20	35.5		41	22.48	36.89		47.06	17.16	35.78			
2 part	681	344	400	1425	413	274	288	975	309	149	249	707	$\chi^2=20.91275$ $p<0.05$	$C_{kor} = 0.100$
%	48	24.14	28.07		42.36	28.10	29.54		43.71	21.07	35.22			
Total	1221	594	836	2651	836	508	672	2016	597	254	468	1319	$\chi^2=22.57075$ $p<0.01$	$C_{kor} = 0.075$
%	46.06	22.41	31.54		41.47	25.20	33.33		45.26	19.26	35.48			

EA: effective attacks; **IA:** ineffective attacks; **PE:** penalties

Table 2. Values of indicators determining the material structure of judo competitors from Japan, Georgia and France.

Details of fighting techniques	Japanese competitors (1)		Georgian competitors (2)		French competitors (3)		Values characterizing differences between groups				
	Number of techniques		Number of techniques		Number of techniques		Technique count distributions				
	N	%	N	%	N	%	Test value, significance level	Strength of relationship	EFF	EFF	
TRUNK ROTATIONS											
Throws with trunk rotations*	939	54.75	2.26 (3*)	678	53.51	2.46 (3*)	353	43.80	1.51	$\chi^2=28.097$ $p<0.01$	Ckor=0.113
Throws without trunk rotations*	776	45.25	2.36 (2*)	589	46.49	3.03	453	56.20	2.56		
Total	1715			1267			806				
KODOKAN DIVISION											
Hand throws *	526	28.98	2.30	367	27.31	2.77 (3*)	230	27.03	1.77	$\chi^2=164.313$ $p<0.01$	Ckor=0.232
Leg throws	892	49.15	2.25	510	37.95	2.40	309	36.31	2.42		
Hip throws	138	7.60	3.35	140	10.42	3.69	50	5.88	3.14		
Sacrifice throw *	159	8.76	1.76 (2*)	250	18.60	2.78 (3*)	217	25.50	1.77		
Ground techniques	100	5.51	9.08	77	5.73	8.66	45	5.29	9.18		
Total	1815			1344			851				
METHOD OF ATTACK (including COUNTERATTACKS)											
Single attacks *	1597	93.12	2.20 (2*)	1130	89.19	2.59 (3*)	727	90.20	2.00	$\chi^2=40.406$ $p<0.01$	Ckor=0.126
Combinations	61	3.56	2.82	33	2.60	1.06	38	4.71	2.55		
Counterattacks	57	3.32	4.65	104	8.21	4.75	41	5.09	3.44		
Total	1715			1267			806				
OPPONENT'S LEANING SIDE											
Right *	882	53.36	2.22 (2*)	596	47.53	2.73	338	45.49	2.12	$\chi^2=16.472$ $p<0.01$	Ckor=0.088
Left	771	46.64%	2.54	658	52.47	2.78	405	54.51	2.29		
Total	1653			1254			743				
DIRECTION OF THE ATTACK											
Front *	1148	68.13	2.12 (3*)	854	68.10	2.53 (3*)	557	69.71	1.51	$\chi^2=0.739$ $p>0.05$	
Back	537	31.87	2.77	400	31.90	3.23	242	30.29	3.45		
Total	1685			1254			799				
PART OF THE FIGHT											
1 part *	1226	46.25	2.55	1041	51.64	2.88 (3*)	612	46.40	2.26		
2 part *	1425	53.75	2.79	975	48.36	3.24 (3*)	707	53.60	2.66		
Total *	2651		2.68	2016		3.06 (3*)	1319		2.48		

EFF: efficiency; *p<0.05

- classification including torso rotation (Ckor = 0.113);
- Kodokan classification (Ckor = 0.232);
- method of attack application (Ckor = 0.126).

The competitors from France most often used throws without torso rotation, while the representatives from Japan and Georgia used throws with rotation. Foot throws were most often used by the Japanese, hip throws by the Georgians, while sacrifice techniques were used by the French. Single attacks prevailed in all the national teams studied, however, competitors from Japan used them most often. The highest frequency of counterattacks was observed in competitors from Georgia. The highest frequency of combinations was observed in French judokas. A weak statistically significant relationship was noted between the membership of the studied national teams and the side of the opponent's lean (Ckor = 0.088). It consisted in the fact that throws to the right side were mostly used by judokas from Japan, to the left by the French.

Comparing the values of the efficiency index in Table 2 recorded in competitors from Japan, Georgia and France, it was found to be statistically significantly different ($H = 13.29$). Two homogeneous groups were formed on the basis of multiple comparisons. They were formed by the values of evaluations in the group: competitors from Japan and France (lower average) and – Japan and Georgia (higher average). Competitors from Georgia had the highest average of referee ratings. It was statistically significantly different from the grades received by the French representatives. Statistically significant differences between the effectiveness of the competitors of the studied national teams also occurred in the areas of: throws with torso rotation; throws without torso rotation; hand throws; sacrifice techniques; single attacks; forward direction of attack; throws applied to the right; 1 (first) part of the fight, and 2 (second) part of the fight.

Total based on the data summarized in Table 2, it was found that the values of ratings of hand throws, attacks in the first and second part of the fight were similar in two groups of competitors from: Japan and France, and Japan and Georgia. Comparing the averages, it was found that the highest occurred in the group of judokas from Georgia and was

statistically significantly different from the ratings of the representatives from France. In terms of throws with torso rotation and forward techniques, two homogeneous groups were formed. They were formed by the evaluation values of the competitors: Japan and Georgia, and France. The lowest average ratings occurred in the group of representatives from France and were statistically significantly different from the average values of ratings of competitors from Japan and Georgia. The results summarized in Table 2 allowed us to conclude that the values of evaluations of: sacrifice techniques, single attacks, throws performed with more than one support point were similar in two groups of judokas from: Japan-France and Georgia

The highest referee ratings for these techniques were given to the Georgian representatives. The value of the ratings for techniques without rotation of the torso and throws performed to the right side were similar in the competitor groups: Japan and France, and France and Georgia. Comparing the averages, it was found that the highest ratings were received by competitors from Georgia, and they were statistically significantly different from the ratings of competitors from Japan.

DISCUSSION

The activity index (WA – understood as the sum of attacks: effective, ineffective and forced penalties on the opponent divided by the number of fights) has already been used to analyse technical-tactical training, among others by Sterkowicz et al. [7]. At the time, he found that medallists in national competitions were characterized by almost twice its value compared to competitors off the podium. Błach et al. [14], on the other hand, noted no relationship between activity and the level of athletic performance of competitors, either in the world championships or the Olympic Games. This was likely influenced by the fact that provoked penalties were not included in his design. In the present study an increase in the value of WA in the second part of the competition was noted in all observed teams. Comparing the results of the present study with those of Lech et al. [15], it was found that the representatives of Japan, France and Georgia showed higher activity compared to judokas from Poland. Additionally, the observed competitors were more likely to perform technical actions in the second part of the competition. In Lech's et

al. study, the regularity was the opposite. This is certainly related to the tactics adopted, but also to physical preparation. The study shows that competitor activity largely determines the oxygen uptake (VO₂max). Judokas who have higher VO₂max values show a smaller decrease in activity in the second part of the fight and overtime. In the cited studies, competitors achieved an average VO₂max value: 40.8 mL/kg/min. Available results indicate a higher value of this indicator in the national teams of other countries, reaching up to 64.9 ±5.5 mL/kg/min [16]. This undoubtedly influenced the observed differences in the values of this indicator.

In our study, it was noted that competitors from Japan are characterized by the highest activity in the fight as well as in its specified fragments (WA1 and WA2). In addition, the difference in the value of the studied indicator between the Japanese national team is significant with the Georgian national team and large with the French national team.

The issue of the proportion of tactical actions in domestic competition was also dealt with by Sterkowicz et al. [7]. This author noted that the proportion of effective attacks in the total activity ranges from 42.8% (lower-level athletic competitors) to 51.6% (medallists), and penalties account for about 25-27% of all actions. This does not correspond with the results of the present study, in which ineffective attacks were the most frequently used (41-46%), and penalties ranged from 31% to 35%. The differences in results may be due to the rank of the observed competition. However, as it seems, the main reason for the discrepancy is the different rules of sports combat. Sterkowicz made the analysis in 1998 and 1999, when competitors during a fight were not penalized as often for passivity and were not required to attack as much.

Analysing the relationship between national team affiliation and the frequency of use of the analysed tactical actions, it was noted that competitors from Georgia had the highest percentage of effective attacks, judokas from France had the highest frequency of forced penalties, while Japanese representatives made the most ineffective attacks. This was a relationship of weak correlation. This regularity also applied to the second part of the fight (moderate relationship).

Comparing the values of the effectiveness index

(WS) between the observed teams, it was found that the highest average referee ratings were obtained by the competitors from Georgia, which confirms the earlier observation about the number of effective attacks carried out during the fight by this team. In the case of the first and second parts of the fight, it was found that the highest WS value occurred in the group of judokas from Georgia and was statistically significantly different from the ratings of the representatives from France where it was the lowest.

The use of throws with trunk rotation seems to depend mainly on the level of coordination abilities. Sterkowicz et al. [7], analysing national competition, noted that competitors more often use throws without torso rotation (medallists: 60.4%; lower-level athletes: 60.6%). In the group of medallists, higher ratings of effective attacks (rated) were given to competitors for techniques combined with torso rotation ($\bar{X} = 7.5$ points), lower for techniques without rotation ($\bar{X} = 6.7$ points). The efficiency of throws (the proportion of effective attacks to all recorded technical actions performed) performed with torso rotation was higher in the medallist group compared to lower-performing competitors. Adam et al. [17], comparing the effectiveness of throws with a torso rotation (the sum of effective attack scores/number of fights), noted their values were almost seven times higher in Japanese competitors compared to their opponents. In the present study, it was noted that competitors from Japan and Georgia showed a preference for using techniques combined with torso rotation (54.8% and 53.5%, respectively). Judokas from France were more likely to perform techniques without rotation (56.2%). At the same time, Georgian judokas performed them most effectively.

The Kodokan classification is one of the most widely used divisions of techniques. Using it for analysis, we can infer the strength and agility of the various parts of a competitor's body, and additionally we get information on specialization in conducting fights in the stand-up, as well as on the ground. Błach et al. [2], on the basis of an analysis of fights during the Warsaw World Cup, found that competitors most often (actions evaluated) performed hand throws (32.8%) and foot throws (28%). A similar observation at the 2008 Olympic Games was made by Witkowski et al. [5]. He found that a significant proportion of fights (66.67%) ended in *nage-waza*, of which *te-waza* (27.06%) and *ashi-waza* (23.43%) often

decided the winner. In our study, we found that, regardless of representation, foot throws were the most frequently used techniques. In the intergroup comparison, a definite dominance of these techniques was noted in the competitors of Japan. In the competitors of Japan and Georgia, hand techniques came second, while in the judokas of France, hand techniques and sacrifices came second.

Adam et al. [17] comparing the effective actions (sum of rated effective attacks/number of bouts) of Japanese competitors and their direct opponents found, their higher effectiveness for foot, hand and hip techniques, and lower for sacrifice throws. Analysing effective actions (rated actions) during the 2003-2009 Japanese championships [8], he showed that competitors from all technique groups were most effective in foot techniques. In the present study, when comparing effectiveness, statistically significant differences were noted only in the case of hand throws, it was found that the highest value of ratings for these techniques occurred in the group of judokas from Georgia.

The way in which an attack is applied, in addition to individual training, seems to be influenced by the chosen fighting tactics. Sterkowicz et al. [7] showed that in domestic competition, 1 in 4 throws is used in combination or as a counterattack, with counterattacks having the highest effectiveness (proportion of effective attacks to all recorded actions). In the present study, it was noted that less than 1 attack in 11 was carried out in combination or as a response to an opponent's attack, with Japanese competitors using such attacks the least frequently. Georgian competitors were characterized by the highest frequency of counterattacks, while combinations were typical of the French. The percentage of single attacks was as follows: Japan 93.12%, Georgia 89.19%, France 90.20%, with the Georgian judokas using them most effectively. Researchers agree that using attacks in different directions significantly increases the chances of winning a judo fight [18, 3].

Adam et al. [19], analysing the way Japanese competitors fought at the national championships between 2003 and 2012, observed that judokas in the open weight category had comparable average effectiveness (sum of effective attack ratings by number of fights) of techniques combined with

leaning the opponent forward as well as backward (3.507 and 3.439). In addition, he found that the differences in the value of ratings of throws used in the four basic directions (front-right, front-left, rear-right, rear-left) were small.

This study did not analyse the number of attack directions used by individual competitors. Therefore, we cannot draw conclusions on this subject. Analysing the technical actions used by the studied groups of competitors, a weak correlation was observed in that Japanese competitors used attacks combined with leaning the opponent to the right side more often than their opponents (53.4%). However, the effectiveness of these techniques was highest in competitors from Georgia.

In Sterkowicz's et al. [7] study, the frequency of right-hand throws in both national competition medallists and lower-performing competitors (55.0% and 53.7%, respectively) was similar to Japanese competitors.

As for the direction of attack (front-back), it was found that in all groups, competitors used forward attacks more often (from 68.13% in Japanese competitors to 69.71 in judokas from France). In addition, the effectiveness of forward attacks was lowest in competitors from France. In national competitions, the frequency of using forward attacks was lower, at 56.1% in medallists and 59.3% in lower-level competitors [7].

CONCLUSIONS

Competitors from Japan showed the highest activity during the fight. This regularity applied to both the 1st and 2nd parts of the fight.

A weak correlation was found between national team membership and the frequency of effective attacks, ineffective attacks and forced penalties. A moderate relationship was found for the 2nd part of the fight.

When comparing the techniques used, a moderate statistically significant relationship was found between the affiliation of the subjects and the classification taking into account torso rotations, Kodokan classification, and the way the attack was applied. A weak correlation was found between the affiliation of the studied teams and the side of the opponent's lean.

Competitors from Georgia had the highest average referee ratings. Statistically significant differences between the effectiveness of the competitor's actions of the studied national teams also occurred in the following areas: throws with torso rotation,

throws without torso rotation, hand throws, sacrifice techniques, single attacks, forward direction of attack, throws applied to the right, and the first part of the fight.

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