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## The course of fight and the level of sports achievements in judo

### Authors' contributions:

**A** Study design  
**B** Data collection  
**C** Statistical analysis  
**D** Data interpretation  
**E** Literature search  
**F** Manuscript preparation  
**G** Funds collection

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### Summary

#### Study aim:

The purpose of this paper was to demonstrate differences in the fighting methods adopted by medallists during All-Polish Judo Competitions in relation to the competitors with a lower level of successes.

#### Material/methods:

The research material was a video recording during the Polish Judo Championships, which took place in Chorzów (Chorzów '98) and Wrocław (Wrocław '99). Each and every tournament fight (n = 518) was statistically analysed in order to define the differences in the values of indices that characterise technical and tactical schooling.

#### Results:

In the recapitulation it was said that the level of the results achieved during the Polish Championships was mostly influenced by the activity of the contestants. Some significant differences were also observed in terms of the effectiveness of particular technical actions and, to some extent, the level of achievements depended on the effectiveness of technical actions and the proportion of tactical actions.

#### Conclusions:

The information mentioned above should be taken into account by coaches when they plan and conduct schooling in their sports clubs

#### Key words:

**judo • level of achievements • technical skills**

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## INTRODUCTION

In these sports where success depends on one or very few ways of performing a given action the definition of the so-called "the model of the champion" seems to be rather easy to define. Its essential elements would describe the basic traits of competitors' body build and their ages [15]. In judo, due to its continuous evolution (which is influenced, among other things, by changes in the fighting rules) and a great number of technical actions, the model of competition should be defined first, that is the requirements which must be met by competitors if they are to achieve successes. Researches focused on judo have quite a long tradition in Poland. The first publications date back to the end of the 60s and the beginning of the 70s [9, 11]. However, the majority of them have been general descriptions of the actions and efficiency of competitors who entered especially for international championship tournaments. In the meantime, the most essential problem seems to lie in how to define the fighting methods applied by the winners of each of these tournaments and how to compare them with the technical and tactical schooling that their opponents have undergone. Very few authors in our country have undertaken this research issue. Drabik [7] has analysed the level of achievements attained by junior judoists in the aspect of their dominant side of the body and the direction they executed their attacks. Adam [1] has employed some indices describing technical and tactical schooling to characterise the fighting methods adopted by the winners during the Twelfth Olympic Games held in Moscow. The results of a comprehensive analysis of the differences in technical and tactical schooling that senior judoists undergo in our country, including the level of their achievements, have been presented only in one paper [13]. Yet, due to the period that this research spans, its results require some verification. The statements and remarks presented above have induced the authors to conduct a new research in this field.

The primary aim of the present research are answers to the following questions:

1. Is the level of achievements attained at Polish championships dependent on:

- actions in attack and the proportion of its components, or
- applied technical actions, their efficiency and effectiveness?

2. What are the optimum values of indices describing the technical and tactical schooling concerning

seniors that condition their attaining of high results during All-Polish competitions?

On the basis of the experiences gained as a competitor and a coach and also based on a review of the literature, a hypothesis has been formulated that competitors of a diverse level of achievements in this sport adopt different fighting methods.

## MATERIAL & METHODS

The research material was a video recording of the Judo Seniors' Championships of Poland which took place in Chorzów (Chorzów '98) and Wrocław (Wrocław '99). Some 518 fights were recorded - 64 hours long (3648 fragments of fight in the standing position, 1214 during groundwork, 3124 intermissions, 1406 technical actions, 514 penalties). A number of lists of fights from seven weight categories were also collected (documents were provided by the Polish Judo Association) which were used to identify the participants and to determine the level of the competitors' achievements (medallists and competitors with a lower level of successes).

While analysing each tournament fights we recorded in Microsoft © Access '97, technical and tactical actions applied by individual competitors. The database thus created was copied to the *STATISTICA PL* program, by means of which the majority of analyses were carried out. The first stage was meant to determine the technical and tactical schooling of the medallists and the competitors with a lower level of successes, and then a comparative analysis was conducted. The study of this technical and tactical schooling included an analysis of the following aspects:

- a) actions of the contestants during attacks and the proportion of their components,
- b) efficiency, and
- c) effectiveness of their technical actions.

The parameter proposed by Sikorski and Łaksa was used during the evaluation of their actions [12]. For the needs of this research, it was converted into the following form:

$$\text{Index of activity (WA)} = \frac{\Sigma A}{NW}$$

where:

$\Sigma A$  – all actions (applied ineffective attacks, effective attacks and the penalties enforced upon the opponent),  $NW$  - the number of fights conducted by every competitor.

The analysis concerning the components of actions consisted in comparing the frequency of distribution of ineffective attacks, effective and enforced penalties.

The effectiveness of actions as a qualitative variable was calculated by means of the following equation:

$$\text{efficiency (S)} = \frac{\text{the\_number\_of\_effective\_techniques}}{\text{the\_total\_number\_of\_techniques}} \times 100\%$$

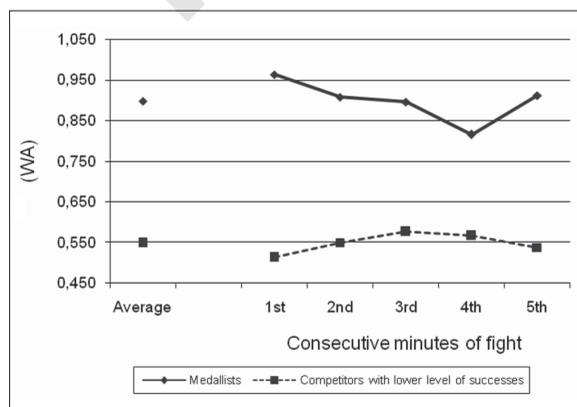
Effectiveness (quantitative variable) was defined by the arithmetic mean scores ( $\bar{X}$ ) for effective attacks. It is expressed by the following formula:

$$\text{effectiveness (E)} = \frac{\text{the\_total\_scores\_obtained}}{\text{the\_number\_of\_effective\_techniques}}$$

In order to make the analysis more comprehensive, the recorded technical and tactical actions were divided according to the following criteria: occurrence of turns around the long axis of the body (with or without rotation), the methods applied during attacks (single attacks, combinations, counter-attacks), the *Kodokan*<sup>1</sup> classification (hand and arm throwing techniques, foot and leg throwing techniques, sacrifice throwing techniques and groundwork actions), direction of attacks (forwards, backwards), the side the opponent was pulled which the attack in question involved (right or left), place where the attack was executed or initiated (on the red strip, in the green part of the contest area), time of actions (minutes of fight).

The efficiency and effectiveness of particular groups of techniques in terms of the above mentioned division was analysed and their frequency distribution was compared.

The chi-squared test for independence between row and column factors was used to compare the fre-



**Figure 1.** The values of the activity index both in the groups of medallists and competitors with a lower level of successes.

quency distribution of the classified actions applied during fight. The strength of this correlation was determined by means of Pearson's adjusted coefficient of convergence Ckor [5]. When interpreting the coefficient of convergence C the following limits of values were adopted:  $C < 0.1$  for a weak correlation,  $0.1 \geq C \leq 0.3$  for a moderate correlation and  $C > 0.3$  for a strong correlation [6].

The analysis of the points revealed that this variable did not have normal distributions. Thus, the following non-parametric equivalents of the ANOVA analysis were used in this research: Kruskal-Wallis's H test and Mann-Whitney's U test [2]. If the number of comparisons in a given group was higher than one, Bonferroni's correction was used in the case of Mann-Whitney's U test, which consisted in dividing the significance level = 0.05 by the number of comparisons [16]. The t-Student test for unrelated variables was also used in order to evaluate the significance level of differences between average values. The similarity of group profiles was evaluated by means of the DuMas index - rsp [3].

## RESULTS

### The actions during fights displayed by competitors with a diverse level of achievements

The index of activity (WA) was used to synthesize the information regarding the number of ineffective attacks, effective attacks and enforced penalties in the consecutive minutes of fights. Its value (fig. 1), in the case of the medallists, was the highest in the first minute of fights (0.963) and the lowest in the fourth (0.815). It increased in the fifth minute, whereas it decreased in the second and especially in the fourth minute.

In the case of the competitors with a lower level of successes, the highest value WA was observed in the third minute of fights (0.576), lowest in the first minute (0.513). It increased in the second and third minute; on the other hand, it dropped in the fourth and fifth minute. In the case of this group, there was a correlation between the frequency of effective attacks, ineffective attacks and enforced penalties as well as minutes of fights (moderate correlation Ckor = 0.141).

This research indicates (Table 1) that in the fourth characteristic minute of fights non-medallists most often, of all the duration of fights, applied effective attacks (50.0% of all actions), yet the proportion of enforced penalties was the lowest (16.3%).

<sup>1</sup> Hip throwing techniques as well as hand and arm throwing techniques have been included in one group – hand and arm throwing techniques.

**Table 1.** Proportions of tactical actions during the consecutive minutes of fights, in the groups of medallists and competitors with a lower level of successes.

	Compared groups								Values that characterise differences between groups	
	Medallists				Competitors with a lower sports level				The value of the test Significance level	Contingency Coefficient
	Ineffective attacks	Effective attacks	Penalties	Total	Ineffective attacks	Effective attacks	Penalties	Total		
1st minute	39	112	53	204	118	164	131	413	$\chi^2=13,35$ ; $p<0,01$	<b>Ckor=0,192</b>
% row	19.1	54.9	26.0		28.6	39.7	31.7			
2nd minute	49	90	44	183	93	133	89	315	$\chi^2=2,33$ ; $p>0,05$	
% row	26.8	49.2	24.0		29.5	42.2	28.2			
3rd minute	29	63	36	128	66	103	69	238	$\chi^2=1,49$ ; $p>0,05$	
% row	22.7	49.2	28.1		27.7	43.3	29.0			
4th minute	21	46	20	87	62	92	30	184	$\chi^2=3,29$ ; $p>0,05$	
% row	24.1	52.9	23.0		33.7	50.0	16.3			
5th minute	13	27	13	53	37	49	29	115	$\chi^2=1,28$ ; $p>0,05$	
% row	24.5	50.9	24.5		32.2	42.6	25.2			
Total	151	338	166	655	376	541	348	1265	$\chi^2=15,11$ ; $p<0,01$	<b>Ckor=0,116</b>
% of Total	23.0	51.6	25.3	100.00%	29.7	42.8	27.5	100		
The value of the test; Significance level	$\chi^2=4,13$ ; $p>0,05$				$\chi^2=16,44$ ; $p<0,05$					
Contingency Coefficient					<b>Ckor=0,141</b>					

Medallists were characterised by almost twice higher values of the activity index (the arithmetic mean WA amounted to 0.898, whereas it equalled 0.548 in the case of the second group). This difference was statistically significant ( $t = 13.32$ ;  $p < 0.01$ ).

There appeared a very low degree of similarity of WA profiles between the compared groups ( $rps = -0.5$ ). However, the divergence of the WA value in the case of the groups of medallists was greater (0.148) than in the competitors with a lower level of successes (0.063).

There was a moderate correlation between the level of achievements of competitors and diverse kinds of their actions ( $Ckor = 0.116$ ). On the basis of the analysis of the data presented in Table 1, it was found that medallists were characterized by a greater share of effective attacks in their all actions (51.6%). However, in the case of the competitors with a lower level of successes – they displayed ineffective techniques in their attacks (29.7%).

The above-mentioned correlation was more intensified in the first minute of fights ( $Ckor = 0.192$ ). During this period of fights, a greater share of effective attacks was noticed in the case of medallists (54.90%) than in the competitors with a lower level of successes (39.7%). However, in the case of competi-

tors with a lower level of successes, ineffective attacks were more frequent (28.57%) and they also enforced penalties (31.72%). In the case of medallists, these values were: 19.1% and 26.0% respectively.

#### The analysis of efficiency and effectiveness of techniques displayed by the group of competitors with a diversified level of achievements

##### A. Medallists

A statistically significant correlation between the effectiveness of technical and tactical actions as well as the two criteria according to which they had been assigned to groups was discovered in the groups of medallists (tab. 2). The strongest correlation was found in their method of attacks (strong Ckor correlation = 0.302), whereas their counter-attacks were characterised by the highest efficiency (89.5%). Their combinations were marked by lower efficiency (81.8%), whereas their single attacks were typified by the lowest efficiency (62.4%). Weaker efficiency was found in the case of techniques described according to the *Kodokan* classification (moderate Ckor dependence = 0.187) and the highest efficiency was discovered in the case of foot and leg throwing techniques (78.3%), lower efficiency characterized sacrifice techniques (73.6%) and groundwork actions (70.2%), the lowest efficiency was found in hand and

**Table 2.** Values of indices determining the material structure of judo fight in the case of medallists.

	Number of techniques						Effectiveness (E)	Notes
	Effective		Ineffective		Total			
	N	% (S)	N	%	N	%		
<i>ROTATIONS OF THE TRUNK</i>								
<b>Throws with a rotation of the trunk</b>	116	66.3	59	33.7	175	39.6	7.8	Techniques applied during groundwork have not been considered
<b>Throws without a rotation of the trunk</b>	189	70.8	78	29.2	267	60.4	7.2	
<b>Total</b>	305	69.0	137	31.0	442	100	7.4	
The value of the test; Significance level	$\chi^2=1.00; p>0.05$						<b>U=2.29; p&lt;0.05</b>	
Contingency Coefficient	.							
<i>THE KODOKAN CLASSIFICATION</i>								
<b>Hand and arm throwing techniques</b>	137	62.0	84	38.0	221	45.2	7.6	Hand and arm throwing techniques as well as hip throwing techniques have been included in one group - hand and arm throwing techniques
<b>Foot and leg throwing techniques</b>	90	78.3	25	21.7	115	23.5	7.4	
<b>Sacrifice throwing techniques</b>	78	73.6	28	26.4	106	21.7	7.1	
<b>Techniques applied during groundwork</b>	33	70.2	14	29.8	47	9.6	8.5	
<b>Total</b>	338	69.1	151	30.9	489	100	7.5	
The value of the test; Significance level	<b><math>\chi^2=10.78; p&lt;0.05</math></b>						<b>H=8.39; p&lt;0.05</b>	
Contingency Coefficient	<b>Ckor=0.187</b>							
<i>METHOD OF ATTACKS</i>								
<b>Single attacks</b>	201	62.4	121	37.6	322	72.9	7.5	Techniques applied during groundwork have not been considered
<b>Combinations</b>	36	81.8	8	18.2	44	10.0	6.5	
<b>Counter-attacks</b>	68	89.5	8	10.5	76	17.2	7.6	
<b>Total</b>	305	69.0	137	31.0	442	100	7.4	
The value of the test; Significance level	<b><math>\chi^2=24.79; p&lt;0.01</math></b>						<b>H=6.22; p&lt;0.05</b>	
Contingency Coefficient	<b>Ckor=0.302</b>							
<i>THE SIDE THE OPPONENT IS PULLED</i>								
<b>Right</b>	160	67.8	76	32.2	236	55.0	7.2	Techniques applied during groundwork and throws applied forwards and backwards have not been considered
<b>Left</b>	138	71.5	55	28.5	193	45.0	7.7	
<b>Total</b>	298	69.5	131	30.5	429	100	7.4	
The value of the test; Significance level	$\chi^2=0.69; p>0.05$						U=1.90; p>0.05	
Contingency Coefficient	.							
<i>DIRECTION OF ATTACKS</i>								
<b>Forwards</b>	159	66.8	79	33.2	238	56.1	7.8	Techniques applied during groundwork and throws applied to the right and left side have not been considered
<b>Backwards</b>	135	72.6	51	27.4	186	43.9	7	
<b>Total</b>	294	69.3	130	30.7	424	100	7.4	
The value of the test; Significance level	$\chi^2=1.64; p>0.05$						<b>U=2.99; p&lt;0.05</b>	
Siła związku								
<i>THE PLACE OF ATTACKS</i>								
<b>Centre of the contest area</b>	275	69.4	121	30.6	396	81.0	7.3	
<b>The red strip</b>	63	67.7	30	32.3	93	19.0	7.6	
<b>Total</b>	338	69.1	151	30.9	489	100	7.5	
The value of the test; Significance level	$\chi^2=0.10; p>0.05$						U=0.82; p>0.05	
Contingency Coefficient								
<i>CONSECUTIVE MINUTES OF FIGHT</i>								
<b>1st minute</b>	112	74.2	39	25.8	151	30.9	7.6	No comparisons have been made as to the frequency distribution of techniques between groups in terms of different number of fights in the consecutive minutes of fights
<b>2nd minute</b>	90	64.8	49	35.2	139	28.4	7.5	
<b>3rd minute</b>	63	68.5	29	31.5	92	18.8	7.7	
<b>4th minute</b>	46	68.7	21	31.3	67	13.7	7.3	
<b>5th minute</b>	27	67.5	13	32.5	40	8.2	7.2	
<b>Total</b>	338	69.1	151	30.9	489	100	7.5	
The value of the test; Significance level	$\chi^2=3.12; p>0.05$						H=0.95; p>0.05	
Contingency Coefficient								

**Table 3.** The scores and significance level of Mann-Whitney's U test, calculated for the groups of hand and arm techniques R, foot and leg throwing techniques N, sacrifice techniques P, and techniques applied in groundwork PA in the groups of medallists (variable – value of the score).

Compared groups	The value of the test	Significance level
R - N	0.87	0.381
R - P	1.48	0.138
R - PA	-2.0	0.045
N - P	0.54	0.583
N - PA	-2.33	0.019
P - PA	-2.7	0.006

arm throwing techniques (62.0%). Significant differences in effectiveness concerned the three criteria according to which techniques were grouped: rotations of the trunk ( $U = 2.29$ ;  $p < 0.05$ ), the *Kodokan* classification ( $H = 8.39$ ;  $p < 0.05$ ), and also the methods attacks were applied ( $H = 6.22$ ;  $p < 0.05$ ). As for the classification that took account of rotations of the trunk, it was demonstrated that higher scores were obtained by medallists for the execution of throws with a rotation ( $\bar{X} = 7.8$  points), lower scores for throws without a rotation of the trunk  $\bar{X} = 7.2$  points).

In the case of the division taking into account the *Kodokan* classification (on the basis of the data listed in table 3), it was ascertained that the highest scores appeared in the group of techniques applied during groundwork ( $\bar{X} = 8.5$  points). They differed from the scores for sacrifice throwing techniques ( $\bar{X} = 7.1$  points). Hand and arm throwing techniques, foot and leg throwing techniques, sacrifice techniques, and also hand and arm techniques, foot and leg throwing techniques as well as groundwork actions formed homogeneous groups.

However when analysing the data shown in Table 4, it is clear that when classifying throws in terms of the methods of the applied attack the lowest scores appeared in the case of combinations ( $\bar{X} = 6.5$  points). They differed significantly from the scores for single attacks ( $\bar{X} = 7.5$  points). The scores for single attacks and counter-attacks as well as combinations and counter-attacks were considered to be homogeneous ones.

## B. Competitors with a lower level of successes

Among the competitors with a lower level of successes (tab. 5) there appeared a moderate correlation between the efficiency of techniques and the four criteria according to which they had been assigned

**Table 4.** The scores and significance level of Mann-Whitney's U test, calculated for the groups of scores for single attacks P, combinations K and counter-attacks PR, in the groups of medallists and competitors with a lower level of successes (variable – value of the score).

Compared groups	The value of the test	Significance level
P - K	2.37	0.02
P - PR	-0.17	0.868
K - PR	-2.29	0.022

to groups: and the method of attacks ( $C_{kor} = 0.219$ ); the direction of attacks ( $C_{kor} = 0.174$ ); the *Kodokan* classification ( $C_{kor} = 0.156$ ); rotations of the trunk ( $C_{kor} = 0.130$ ). Counter-attacks were characterised by the highest efficiency among the methods of attacks (75.6%), lower efficiency characterized combinations (65.8%), whereas their single attacks were typified by the lowest efficiency (53.0%). Backward throwing techniques were characterised by higher efficiency (64.9%), lower efficiency characterized forward throwing techniques (52.4%). However when analysing the techniques described according to the *Kodokan* classification, it was demonstrated that the techniques during groundwork were applied by the competitors most effectively (73.8%), lower efficiency characterised foot and leg throwing techniques (62.6%) and sacrifice techniques (60.3%). The lowest efficiency characterised hand and arm techniques (53.5%). Somewhat higher efficiency characterized throws without a rotation (61.2%), lower efficiency characterized throws with a rotation of the trunk (51.8%). The significant differences in the effectiveness of techniques concerned the following aspects: the division taking account of rotations of the trunk ( $U = 3.20$ ;  $p < 0.01$ ), division taking into account the *Kodokan* classification ( $H = 21.28$ ;  $p < 0.01$ ), direction of attacks ( $U = 3.27$ ;  $p < 0.01$ ), and also minutes of fights ( $H = 10.50$ ;  $p < 0.05$ ). Higher scores were received by competitors for techniques combined with a rotation of the trunk ( $\bar{X} = 7.5$  points). Lower scores were obtained in the case of techniques without a rotation ( $\bar{X} = 6.7$  points).

When analysing the data shown in Table 6, it becomes clear that in terms of the division taking into account the *Kodokan* classification the highest scores were obtained for groundwork actions ( $\bar{X} = 8.3$  points). Their scores differed from the value of sacrifice throwing techniques ( $\bar{X} = 6.6$  points), hand and arm techniques ( $\bar{X} = 7.1$  points) and foot and leg throwing techniques ( $\bar{X} = 7.3$  points). The scores for sacrifice throwing techniques, hand and leg throwing techniques formed a homogeneous group. Competitors received higher scores for the execution of forward

**Table 5.** The values of indices describing the material structure of judo fights of non-medallists.

	Number of techniques						Effectiveness (E)	Notes
	Effective		Ineffective		Total			
	N	% (S)	N	%	N	%		
<i>ROTATIONS OF THE TRUNK</i>								
<b>Throws with a rotation of the trunk</b>	170	51.8	158	48.2	328	39.4	7.5	Techniques applied during groundwork have not been considered
<b>Throws without a rotation of the trunk</b>	309	61.2	196	38.8	505	60.6	6.7	
Total	479	57.6	354	42.5	833	100	7.0	
The value of the test; Significance level	<b><math>\chi^2=7.13</math>; <math>p&lt;0.01</math></b>						<b><math>U=3.20</math>; <math>p&lt;0.01</math></b>	
Contingency Coefficient	<b><math>C_{kor}=0.130</math></b>							
<i>THE KODOKAN CLASSIFICATION</i>								
<b>Hand and arm throwing techniques</b>	221	53.5	192	46.5	413	45.0	7.1	Hand and arm throwing techniques as well as hip throwing techniques have been included in one group - hand and arm throwing techniques
<b>Foot and leg throwing techniques</b>	132	62.6	79	37.4	211	23.0	7.3	
<b>Sacrifice throwing techniques</b>	126	60.3	83	39.7	209	22.8	6.6	
<b>Techniques applied during groundwork</b>	62	73.8	22	26.2	84	9.2	8.3	
Total	541	59.0	376	41.0	917	100	7.1	
The value of the test; Significance level	<b><math>\chi^2=14.01</math>; <math>p&lt;0.01</math></b>						<b><math>21.28</math>; <math>p&lt;0.01</math></b>	
Contingency Coefficient	<b><math>C_{kor}=0.156</math></b>							
<i>METHOD OF ATTACKS</i>								
<b>Single attacks</b>	336	53.0	298	47.0	634	76.1	7.0	Techniques applied during groundwork have not been considered
<b>Combinations</b>	50	65.8	26	34.2	76	9.1	6.5	
<b>Counter-attacks</b>	93	75.6	30	24.4	123	14.8	7.1	
Total	479	57.5	354	42.5	833	100	7.0	
The value of the test; Significance level	<b><math>\chi^2=23.91</math>; <math>p&lt;0.01</math></b>						<b><math>H=2.32</math>; <math>p&gt;0.05</math></b>	
Contingency Coefficient	<b><math>C_{kor}=0.219</math></b>							
<i>THE SIDE THE OPPONENT IS PULLED</i>								
<b>Right</b>	242	57.6	178	42.4	420	53.7	6.94	Techniques applied during groundwork and techniques applied forwards and backwards have not been considered
<b>Left</b>	208	57.5	154	42.5	362	46.3	7.07	
Total	450	57.5	332	42.5	782	100	7.0	
The value of the test; Significance level	$\chi^2=0.00$ ; $p>0.05$						<b><math>U=0.58</math>; <math>p&gt;0.05</math></b>	
Contingency Coefficient								
<i>DIRECTION OF ATTACKS</i>								
<b>Forwards</b>	252	52.4	229	47.6	481	59.3	7.4	Techniques applied during groundwork and techniques applied to the right and left side have not been considered
<b>Backwards</b>	214	64.9	116	35.1	330	40.7	6.6	
Total	466	57.5	345	42.5	811	100	7.1	
The value of the test; Significance level	<b><math>\chi^2=12.43</math>; <math>p&lt;0.01</math></b>						<b><math>U=3.27</math>; <math>p&lt;0.01</math></b>	
Contingency Coefficient	<b><math>C_{kor}=0.174</math></b>							
<i>THE PLACE OF ATTACKS</i>								
<b>Centre of the contest area</b>	435	58.6	307	41.4	742	80.9	7.2	
<b>The red strip</b>	106	60.6	69	39.4	175	19.1	7.0	
Total	541	59.0	376	41.0	917	100	7.1	
The value of the test; Significance level	$\chi^2=0.22$ ; $p>0.05$						<b><math>U=0.73</math>; <math>p&gt;0.05</math></b>	
Contingency Coefficient								
<i>CONSECUTIVE MINUTES OF FIGHT</i>								
<b>1st minute</b>	164	58.2	118	41.8	282	30.8	7.0	No comparisons have been made as to the frequency distribution of techniques between groups in terms of different number of fights in the consecutive minutes of fights
<b>2nd minute</b>	133	58.9	93	41.5	226	24.7	7.7	
<b>3rd minute</b>	103	61.0	66	39.0	169	18.4	6.7	
<b>4th minute</b>	92	59.7	62	40.3	154	16.8	7.1	
<b>5th minute</b>	49	57.0	37	43.0	86	9.4	7.6	
Total	541	59.0	376	41.0	917	100	7.2	
The value of the test; Significance level	$\chi^2=0.53$ ; $p>0.05$						<b><math>H=10.50</math>; <math>p&lt;0.0</math></b>	
Contingency Coefficient								

**Table 6.** The scores and significance level of Mann-Whitney's U test, calculated for the groups of hand and arm techniques R, foot and leg throwing techniques N, sacrifice techniques P and techniques applied during groundwork PA in the group of the contestants with a lower sports level (variable – value of the score).

Compared groups	The value of the test	Significance level
R - N	-0.49	0.619
R - P	1.89	0.057
R - PA	-3.5	0.000
N - P	2.09	0.035
N - PA	-2.87	0.004
P - PA	-4.63	0.000

attacks ( $\bar{X} = 7.4$  points) and lower scores for actions directed backwards ( $\bar{X} = 6.6$  points). On the basis of the analysis of the data presented in Table 7, it was found that the lowest scores appeared in the third minute ( $\bar{X} = 6.7$  points). They differed from the value of the scores occurring in the second minute of fights ( $\bar{X} = 7.7$  points).

### C. The comparison of the distribution of the applied techniques, their efficiency and effectiveness between the contestants with diversified levels of successes

There was no statistically significant correlation between the level of achievements and any of the criteria applied to classify techniques (tab. 8).

However a moderate correlation was demonstrated between the level of achievements and effectiveness ( $C_{kor} = 0.140$ ). It consisted in the fact that in the groups of medallists the efficiency of techniques was higher (69.1%) than in the group of competitors with a lower level of successes (59%). The above mentioned correlation of a moderate intensity appeared also in the case of the following aspects: counter-attacks ( $C_{kor} = 0.239$ ), foot and leg throwing techniques ( $C_{kor} = 0.225$ ), in the first minute of fights ( $C_{kor} = 0.222$ ), throwing techniques executed with a rotation of the trunk ( $C_{kor} = 0.195$ ), techniques applied to the left side ( $C_{kor} = 0.193$ ), forward throwing techniques ( $C_{kor} = 0.192$ ), sacrifice throwing techniques ( $C_{kor} = 0.184$ ), techniques applied in the centre of the contest area ( $C_{kor} = 0.150$ ), techniques applied to the right side ( $C_{kor} = 0.141$ ), throwing techniques performed without a rotation of the trunk ( $C_{kor} = 0.134$ ), single attacks ( $C_{kor} = 0.125$ ), as well as hand and arm throwing techniques ( $C_{kor} = 0.115$ ).

Significantly higher effectiveness in the group of medallists appeared was connected with: single attacks (medallists -  $\bar{X} = 7.5$  points); competitors with a lower

**Table 7.** The scores and significance level of Mann-Whitney's U test, calculated for minutes of fights in the group of contestants with a lower sports level (variable – value of the score).

Compared minutes	The value of the test	Significance level
1 - 2	-2.23	0.026
1 - 3	0.76	0.446
1 - 4	-0.49	0.624
1 - 5	-1.51	0.132
2 - 3	2.83	0.0046
2 - 4	1.55	0.121
2 - 5	0.01	0.992
3 - 4	-1.16	0.246
3 - 5	-2.04	0.041
4 - 5	-1.13	0.258

sports level -  $\bar{X} = 7$ ); throwing techniques executed to the left side ( $\bar{X} = 7.7$  and  $\bar{X} = 7.1$  respectively); in the third minute of fight ( $\bar{X} = 7.7$  and  $\bar{X} = 6.7$  points).

### DISCUSSION

The sports-related value of any competitor (besides the specific profile of psychic predispositions) is a resultant product of technical skills, level of motor abilities (strength, speed and endurance) and which are, in the majority of cases, of superior functions - tactical skills [8]. While interesting the results of our own observations of fights, it is difficult to univocally show what were the causes of the differences we noticed.

When analysing the actions of the contestants (WA), we discovered the value of this index was almost twice as high in the group of medallists. Considerable differences were also noticed due to the inter-group comparison of changes in this index during the consecutive minutes of fights ( $r_{ps} = -0.5$ ). The actions of competitors with a lower level of achievements did not change significantly (the divergence of the WA value = 0.063). However in the case of medallists, it clearly decreased in the second and fourth minute and it increased in the fifth minute (WA = 0.148). This higher activity of medallists during the entire fight should be explained by better endurance preparation (special endurance). The changes in the activity during attacks could be connected with the adopted fighting tactics – which was especially typical for competitors with a higher level of achievements.

The significance of activity during judo fights has been accentuated also by Sterkowicz and Kęsek [13]. They have stated that together with effectiveness of actions it is activity that mostly influences the level of successes

**Table 8.** Values of indices describing the differences between groups.

	Distributions of number of techniques in total		Distribution of number of effective techniques and ineffective techniques		Notes
	The value of the test; Significance level	Contingency Coefficient	The value of the test; Significance level	Contingency Coefficient	
<i>ROTATIONS OF THE TRUNK</i>					
<b>Throws with a rotation of the trunk</b>	$\chi^2=0.01$ ; $p>0.05$	.	$\chi^2=9.72$ ; $p<0.01$	<b>Ckor=0.195</b>	Techniques applied during groundwork have not been considered
<b>Throws without a rotation of the trunk</b>			$\chi^2=7.03$ ; $p<0.01$	<b>Ckor=0.134</b>	
<i>THE KODOKAN CLASSIFICATION</i>					
<b>Hand and arm throwing techniques</b>	$\chi^2=0.28$ ; $p>0.05$	.	$\chi^2=4.21$ ; $p<0.05$	<b>Ckor=0.115</b>	Hand and arm throwing techniques as well as hip throwing techniques have been included in one group - hand and arm throwing techniques
<b>Foot and leg throwing techniques</b>			$\chi^2=8.44$ ; $p<0.01$	<b>Ckor=0.225</b>	
<b>Sacrifice throwing techniques</b>			$\chi^2=5.45$ ; $p<0.05$	<b>Ckor=0.184</b>	
<b>Techniques applied during groundwork</b>			$\chi^2=0.20$ ; $p>0.05$		
<i>METHOD OF ATTACKS</i>					
<b>Single attacks</b>	$\chi^2=1.71$ ; $p>0.05$	.	$\chi^2=7.71$ ; $p<0.01$	<b>Ckor=0.125</b>	Techniques applied during groundwork have not been considered
<b>Combinations</b>			$\chi^2=3.53$ ; $p>0.05$	<b>Ckor=0.239</b>	
<b>Counter-attacks</b>			$\chi^2=5.84$ ; $p<0.01$		
<i>THE SIDE THE OPPONENT IS PULLED</i>					
<b>Right</b>	$\chi^2=0.19$ ; $p>0.05$	.	$\chi^2=6.60$ ; $p<0.05$	<b>Ckor=0.141</b>	Techniques applied during groundwork and techniques applied forwards and backwards have not been considered
<b>Left</b>			$\chi^2=10.58$ ; $p<0.01$	<b>Ckor=0.193</b>	
<i>DIRECTION OF ATTACKS</i>					
<b>Forwards</b>	$\chi^2=1.16$ ; $p>0.05$	.	$\chi^2=13.51$ ; $p<0.01$	<b>Ckor=0.192</b>	Techniques applied during groundwork and techniques applied to the right and left side have not been considered
<b>Backwards</b>			$\chi^2=3.25$ ; $p>0.05$		
<i>THE PLACE OF ATTACKS</i>					
<b>Centre of the contest area</b>	$\chi^2=0.00$ ; $p>0.05$	.	$\chi^2=12.88$ ; $p<0.01$	<b>Ckor=0.150</b>	
<b>The red strip</b>			$\chi^2=1.34$ ; $p>0.05$		
<i>CONSECUTIVE MINUTES OF FIGHT</i>					
<b>1st minute</b>			$\chi^2=10.91$ ; $p<0.01$	<b>Ckor=0.222</b>	No comparisons have been made as to the frequency distribution of techniques between groups in terms of different number of fights in the consecutive minutes of fights
<b>2nd minute</b>			$\chi^2=1.26$ ; $p>0.05$		
<b>3rd minute</b>			$\chi^2=1.46$ ; $p>0.05$		
<b>4th minute</b>			$\chi^2=1.58$ ; $p>0.05$		
<b>5th minute</b>			$\chi^2=1.26$ ; $p>0.05$		
<b>Total</b>			$\chi^2=13.95$ ; $p<0.01$	<b>Ckor=0.140</b>	

during competitions. The results of the researches conducted so far describe one general schema how judo fights are conducted [10, 12, 14], which is characterised by a gradual progression of activity from the first to the third minute, its decrease in the fourth and its increase (its value being determined by the level of sports competition) in the final minute. In spite of certain differences in research methodology, it seems that activity in the final phase still remains essential for the result of fights if we consider it from the aspect of its dynamics. However, Calmet and Ahmaidi [4] have paid greater attention to the number of directions of body inclination during throwing techniques executed during attacks and these authors observed an upward trend in more advanced and older competitors.

This research has revealed that the techniques applied did not influence the level of successes. The quality with which they are performed (efficiency and ef-

fectiveness) was a factor differentiating the compared groups. The weak correlations between the result during competitions and effectiveness of actions during fights should be explained by a generally higher efficiency of medallists. The significantly higher efficiency of medallists in the first minute of fights, which influenced the changes in proportion of tactical actions and also counter-attacks themselves and foot and leg throwing techniques, suggests that this aspect should be included during the preparation of contestants. Similarly, we should utilise the information regarding the higher effectiveness of medallists in the case of single attacks, throwing techniques executed to the left side, and the third minute of fights.

#### RECAPITULATION AND CONCLUSION

On the basis of the conducted research, the following remarks could be formulated:

1. the actions of medallists were characterised by:

a) high efficiency:

- counter-attacks and combinations;
- foot and leg throwing techniques, sacrifice techniques and groundwork actions.

b) high effectiveness:

- throwing techniques connected with a rotation of the trunk;
- groundwork actions;
- single attacks and counter-attacks.

2. Competitors with a lower level of successes were characterised by:

a) changes in the proportion of tactical actions during fights;

b) High efficiency was present in their:

- counter-attacks and combinations;
- backward throwing techniques;
- groundwork actions, foot and leg throwing techniques and sacrifice techniques;
- throws without a rotation of the trunk.

c) Their higher effectiveness was visible during:

- throws with a rotation of the trunk,
- groundwork actions,

- forward throwing techniques,
- the second minute of fights.

3. The level of successes during Polish championships was influenced by the activity of the contestants, effectiveness of actions, efficiency of technical actions and proportions of tactical actions (moderate correlations).

4. The levels of indices describing the fighting method adopted by medallists during the All-Polish Competitions may be utilised when modelling training sessions at sports clubs. The typical levels were found in the following aspects:

- activity:  $WA = 0.898$ , which increased considerably during the final minute;
- proportions of tactical actions (ineffective attacks, effective attacks, provoked penalties): 23.0% - 51.6% - 25.3%;
- efficiency: 69.1%;
- effectiveness: 7.5 points.

## CONCLUSIONS

Observation and analysis of the present international championships should provide coaches of the National Team with information on the requirements imposed by fights on representatives of the country.

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