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THE TECHINCAL-TACTICAL PROFILE OF WORLD BEST JUDOKAS IN THE MIDDLEWEIGHT CATEGORY

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Original research

Abstract
The aim of this research is to analyze the technical-tactical profile of the World's best judokas in the middleweight category (under 90kg) and to determine if there is a significant difference between the top ten and the other elite judokas in the nage-waza used at the high-level competitions. The sample included 142 combats from major tournaments held in 2017 and 2018. Inclusion criteria was that one of the judokas engaged in the fight was ranked among the top ten athletes in the middleweight category on the world ranking list. The results show that the most frequently used nage-waza group was te-waza, followed by ashi-waza, sutemi-waza, and koshi-waza. Efficiency index values follow the same order with te-waza (Sa=3.25) and ashi-waza (Sa=2.14) as the most efficient group of throwing techniques. Results of the Chi-square test ($p<0.05$) show that the top ten athletes use more koshi-waza and less-sutemi waza compared to their less successful counterparts. Uchi-mata and sode-tsurikomi-goshi are the main attacking techniques accompanied by te-waza techniques (uchi-mata-sukashi, sumi-otoshi) used commonly to punish the opponent's mistake. Coaches and analysts can value the information provided since it is category-specific, and make extensive use of it in the technical and tactical preparation for the high-level competitions.

Keywords: performance analysis, competition efficiency, combat sports

Introduction

International Judo Federation (IJF) consists of 205 National Federations, which makes judo one of the most widely spread combat sports. IJF's Sport and Organization rules prescribe three ways to win the combat: 1) by using one of the throwing techniques (nage-waza) which are divided into arm/hand techniques (te-waza), leg/foot techniques (ashi-waza), hip techniques (koshi-waza) and sacrifice techniques (sutemi-waza); 2) by using on of the submission techniques (katame-waza) which is divided into immobilization techniques (osaekomi-waza), choking/strangulation techniques (shime-waza) and joint-lock techniques (kansetsu-waza); 3) in the situation where the opponent has received the disqualifying penalty (hansoku-make) (IJF, 2018; Miarka, Julio, Del Vecchio, Calmet & Franchini, 2010). There are multiple means available to achieve this goal. 68 techniques in the standing fight and 32 techniques in the fight on the ground are officially named by the biggest authority in Judo (Kodokan Judo Institute, 2018). Variations and combinations of mentioned techniques give even more opportunities to a judoka to win a fight. Technical richness is the point of interest for the coaches, but also for the sports scientists. One is looking for a way to make their competitor win, and the others are trying to develop an understanding and enhance sports performance. For this purpose, performance analysis has been used in judo, mainly for technical-tactical analysis. Different topics have been considered in order to reveal the most important aspects of judo combat. The main areas covered are technical skills and effectiveness (Adam, 2007; Dornowski, Jagiello & Smaruj, 2011; Adam et al., 2012; Adam, Smaruj & Pujszo, 2012; Adam, Laskowski, Tabakov & Smaruj, 2013; Ito et al., 2013; Miller, Collins, Stewart & Challis, 2015; Gutiérrez-Santiago, Gentico-Merino & Prieto-Lage, 2019; Pereira Martins et al. 2019), time-motion analysis (Miarka et al., 2012; Miarka et al., 2016a; Miarka et al., 2016b), gripping (Courel, Franchini, Femia, Stankovic & Escobar-Molina, 2014; Kajmovic & Radjo, 2014, Kajmovic, Radjo, Mekic, Crnogorac & Colakhodzic, 2014; Miarka, Fukuda, Del Vecchio & Franchini, 2016; Dal Bello, Aedo-Muñoz, Brito & Miarka, 2019; Barreto et al., 2019), defensive actions (Boguszewski, 2009; Boguszewski, 2011a), and penalties (Escobar-Molina, Courel, Franchini, Femia & Stankovic 2014; Calmet,

Pierantozzi, Sterkowicz, Challis & Franchini, 2017; Katicips, Júnior, Kons & Detanico, 2018).

Technical schooling is valued by the coaches to be the most important professional activity conducted by the coach of the athlete (Sterkowicz, Garcia Garcia & Lerma, 2007). Different approaches have been used in order to provide more precise information about the technical aspects of the judo fight. A group of Polish authors analyzed the individual technical-tactical profile of a small number of the best Polish international judokas (Adam, 2007) and the best World judokas (Adam, Smaruj, Pujszo, 2012). More often, the subject of technical analysis was some important championship or tournament (Kajmovic & Radjo, 2014; Miller et al. 2015; Stanković, Cuk, Milosevic & Stamenkovic, 2015; Gutiérrez-Santiago, Gentico-Merino & Prieto-Lage, 2019; Pereira Martins et al. 2019). Different anthropometric size and physical capacity made valid the approach by which analyze is conducted in only one weight category. Articles which discuss the technical-tactical aspects in under 73kg (Gutiérrez-Santiago, Gentico-Merino & Prieto-Lage, 2019), under 81kg (Miarka, Fukuda, Del Vecchio & Franchini, 2016) and absolute category (Adam et al., 2013) brought a better understanding of the category-specific technical profile of the judo athletes.

The aim of this research is to analyze the technical-tactical profile of the World's best judokas in the middleweight category (under 90kg) and to determine if there is a significant difference between the top 10 and the other elite judokas in the nage-waza used at the high-level competitions. The main point is to create a profile of naga-waza in the middleweight category and to compare it to previously published technical profiles of the world's best judokas.

Methods

Subjects

The sample included 142 combats from major tournaments held in 2017 and 2018 (Masters, Grand Slam, Grand Prix, and European Championship). Inclusion criteria was that one of the judokas engaged in the fight was ranked among the top ten athletes in the under 90kg category (not less than 10 by every competitor, range 11-20, median 15) on the International Judo Federation World Ranking List (Accessed on 27.08.2018). The sample was obtained from the IJF and EJU website and the official Dartfish channel. It is confirmed that there are no ethical issues since the data was gathered from an open access website, and participants' personal information is not reported (Calmet et al., 2017).

Instrument

The observational instrument (table 1) was created for the purpose of the study. Combat minute and type of action were analyzed following a previously validated protocol (Courel et al. 2014, Stankovic et al., 2015). Score and technique were analyzed as in the research of Gutiérrez-Santiago, Gentico-Merino & Prieto-Lage (2019).

Table 1 Observational instrument description

Criteria	Description		Description
Outcome	Won		Lost
Top 10 Judoka	Tori		Uke
Time	1st min: 0´00" – 1´00"		3rd min: 2´01" – 3´00"
	2nd min: 1´01" – 2´00"		4th min: 3´01"– 4´00"
	Golden Score: extra time		
Type of action	Score		No score
	Penalty		Ne waza score
Score	No score		Wazaari
	Ippon		Shido 1
	Shido 2		Shido 3/Hansoku make
Nage-waza	ashi-guruma	deashi-barai	hiza-guruma
ashi-waza	kosoto-gake	kosoto-gari	osoto-gari
	kouchi-gake	kouchi-gari	ouchi-gari
	uchi-mata	okuri-ashi-barai	tsubame-gaeshi
	osoto-gaeshi	o-guruma	sasae-tsurikomi-ashi
te-waza	ippon-seoi-nage	seoi-otoshi	seoi nage
	obi-tori-gaeshi	kata-guruma	sumi-otoshi
	uchimata-sukashi	yama-arashi	tai-otoshi
koshi-waza	koshi-guruma	o-goshi	tsuri-goshi
	uki-goshi	harai-goshi	sode-tsurikomi-goshi
	utsuri-goshi		
sutemi-waza	sumi-gaeshi	tomoe-nage	yoko-guruma
	tani-otoshi	ura-nage	ko-uchi-makikomi
	yoko-gake	harai-makikomi	soto-makikomi

The data were analyzed by two experts with a minimum of 20 years of judo experience, 3rd Dan-degree black belt and Ph.D. in sports science. To test the reliability of measures inter-observer and intra-observer testing procedures were made. Inter-observer agreement was conducted by analyzing the same 10 matches by two observers. Afterward, one of the experts has carried out an intra-observer agreement by analyzing two times another 10 fights in a randomized order. The second analysis was conducted one week after the first. Kappa values and strength of agreement classifications were determined as follows: 0.0 to 0.2, poor; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; 0.81 to 1.00, almost perfect (Hopkins, 2000). The index and classification of Kappa values of the type of action and score used in the present study for Inter-expert and Intra-expert measurements were 0.88 and 0.96, classified as "almost perfect" and "almost perfect"; for the technique, 0.73 and 0.84, classified as "substantial" and "almost perfect".

Procedure and Statistical analysis

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All the actions were analyzed in Lince digital software for sports performance analysis (Gabín, Camerino, Anguera & Castañer, 2012). Effectiveness of attacks was determined as a proportion of the number of attacks, for which points were granted, to the number of attacks made (Boguszewski, 2014). To calculate attack efficiency indexes of the judo techniques method suggested by Adam (2007) and Miller, Collins, Stewart, & Challis (2015) was used.

$Sa = (7 \times W) + (10 \times 1) / n$

Where:

Sa – efficiency index

W, I – number of attacks scoring for Wazari (W) and Ippon (I)

n – number of contests

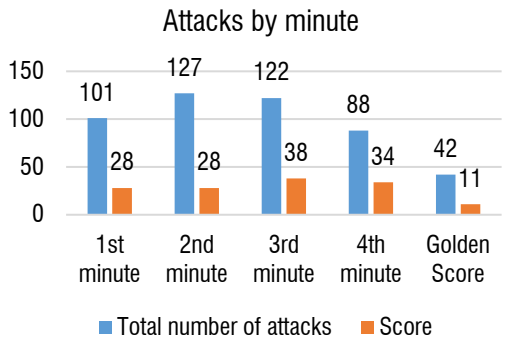
% of successful attacks = (No. of successful attacks / total number of attacks) x 100

The percentage was used for presenting the general data about the fights conducted (number of attacks, scores, penalties, etc.). For testing the differences in nage waza used by the Top 10 and other lower-ranked judokas, the non-parametric chi-square test was performed.

Results

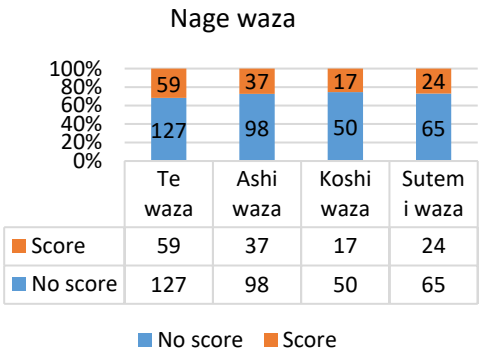
In 142 fights that were analyzed, experts counted for 830 actions: unsuccessful attacks (342, 41%), successful attacks (139, 17%), successful ne-waza attacks (17, 2%) and awarded penalties (332, 40%). There was a total of 481 attacks from which 139 were validated as scores by the referees. In total 52 ippon and 87 waza-ari techniques were registered.

Figure 1 Time structure of offensive activity



The most offensive attitude of judokas can be seen in the second minute of the fight (Figure 1), but their attack effectiveness during this minute was lowest (0.22). Less activity was registered in the final minute of the fight. Still, in the fourth-minute attack effectiveness was the highest (0.39), followed by third (0.31) and first minute (0.28), and Golden score time (0.26).

Figure 2 Nage waza throwing attempts and scores



All throwing techniques are divided into four groups: hand/arm techniques (te-waza), leg/foot techniques (ashi-waza), hip techniques (koshi-waza) and sacrifice techniques (sutemi-waza). Most frequently used were te-waza techniques, followed by ashi-waza, sutemi-waza and koshi-waza (Figure 3). Efficiency values follow the same order with te-waza (Sa=3.25) and ashi-waza (Sa=2.14) as the most efficient group of techniques (Table 2).

Table 2 Indices of efficiency value (Sa) for each of the throw types for the overall competition

Score	te-waza	ashi-waza	koshi-waza	sutemi-waza	nage-waza
waza-ari	43	22	6	16	87
ippon	16	15	11	8	50
Sa	3.25	2.14	1.07	1.35	7.81

To compare the differences in nage waza used by the op 10 and other lower-ranked judokas, the non-parametric chi-square test was performed. Results show that there are significant differences between the samples ($p<0.05$). Standard residuals show that elite athletes use more koshi-waza and less sutemi-waza compared to their less successful counterparts.

Table 3 Chi-Square Tests

	Value	df	p
Pearson Chi-Square	31,017[a]	3	,000
Likelihood Ratio	33,210	3	,000
Linear-by-Linear Association	,786	1	,375
N of Valid Cases	477		

0 cells (,0%) have expected count less than 5.
The minimum expected count is 28,65.

Table 4 Athlete's rank * Nage waza Crosstabulation

		Nage waza used				
		Te waza	Ashi waza	Koshi waza	Sutemi waza	Total
TOP10	Count	103	79	56	35	273
	SR	-,3	,2	2,9	-2,2	
Other	Count	83	56	11	54	204
	SR	,4	-,2	-3,3	2,6	
Total	Count	186	135	67	89	477

SR – Standard Residual

To determine which technique is the most effective, indices of efficiency value (Sa) were calculated. In table 3, the top 10 ranked throws were presented. According to classification of Adam (2007) these 10 techniques can be divided into a) basic, Sa above 1 (uchi-mata) b) auxiliary, Sa between 0.99 and 0.50 (uchi-mata-sukashi, sumi-otoshi and sode-tsurikomi-goshi) c) situational, Sa between 0.50 and 0.15 (sumi-gaeshi, seoi-nage, kata-guruma, ouchi-gari, ippon-seoi-nage and ura-nage). There is also the last, fourth, group of techniques and it is called "at random" ("occasional"), their "Sa" was less than 0.15 pts, and they are not shown in the results.

Table 5 Top 10 ranked throws in order of the efficiency value (Sa)

Technique	waza-ari	ippon	Total	Sa
uchi-mata	14	8	22	1.25
uchi-mata-sukashi	12	4	16	0.87
sumi-otoshi	9	5	14	0.80
sode-tsurikomi-goshi	4	5	9	0.55
sumi-gaeshi	7	2	9	0.49
seoi-nage	8	1	9	0.46
kata-guruma	6	2	8	0.44
ouchi-gari	4	3	7	0.41
ippon-seoi-nage	5	0	5	0.25
ura-nage	2	2	4	0.24

Discussion

The results obtained have confirmed the standpoint that te-waza and ashi-waza techniques are dominant in judo combat. Prior to 2010. the dominance of using te-waza techniques in the combat was evident. On the highest level of competition (gold medal matches on the top judo tournaments for seniors), it was reported that most frequently used judo techniques have belonged to the te-waza group, followed by ashi-waza, sutemi-waza, and koshi-waza (Boguszewski, 2011b). The same results were reported for the cadet age group (Kajmovic et al., 2014). After successive rule changes in previous years (2010, 2013, 2015, 2017) International Judo Federation expected that the balance will change toward increased use of ashi-waza. It is assumed that forbidding the leg grab will make judokas change their fighting style. Stankovic (2015) confirmed the decrease in the use of te-waza techniques after the change of rules applied in 2013., stating that te-waza accounted for 31% of attempted techniques, ashi-waza for 30%, sutemi-waza for 24% and koshi-waza for 15% of the attacks committed at the 2014 World Championship. In a research made by Gutiérrez-Santiago, Gentico-Merino & Prieto-Lage (2019) the technical-tactical patterns of the scoring actions in judo combat were analyzed (−73 kg males, Judo World Championship 2017). They found that ashi-waza accounted for 43% of attacks committed, followed by te-waza 32%, sutemi-waza 18%, and koshi-waza with 7%. Our results didn't confirm the same trend with te-waza (39%) being the most used nage-waza group, followed by ashi-waza (28%), sutemi-waza (19%) and koshi-waza (14%). A possible explanation for this difference can be different weight categories being analyzed (-73kg and -90kg).

The Chi-square test results show that there are significant differences between the samples, and that elite athletes use more koshi-waza and less sutemi-waza. This finding is important since the only research familiar to the authors that compared the winning and losing judo athletes showed that there are no differences in the nage-waza used (Miarka, Fukuda, Del Vecchio & Franchini, 2016). More research is needed in order to clarify the possible difference in the technical means used by elite athletes and other, lower-ranked judokas.

When analyzing the Attack Efficiency Index of the nage-waza groups used we can conclude that in the under 90kg category most efficient techniques are te-waza techniques (3.25), followed by ashi-waza (2.14), sutemi-waza (1.35) and koshi-waza (1.07). These results are not in accordance with other research that pointed out ashi-waza techniques as being the most efficient nage-waza (Adam et al. 2013; Ito et al. 2014; Miller et al. 2015). Inconsistent results were reported by Adam et al. (2012). They concluded that on the Olympic Games 2008 and 2012, and on the World Championship 2009 te-waza had the highest efficiency index, while on World Championship 2010 and 2011 it was ashi-waza. Based on the facts presented, it is necessary to follow up constantly on the value of the Attack Efficiency Index, due to an observed variation in results obtained.

In the articles that analyzed the national championship of Japan (2003-2009), Great Britain (2013) and Bosnia and Herzegovina (2013,2014) efficiency index for the individual technique was determined (Adam et al. 2012; Kajmovic & Radjo, 2014; Miller et al., 2015). By using the division suggested by Adam (2007), from the above-mentioned articles we can distinguish two techniques classified as "basic" (uchi-mata, ippon-seoi-nage) and four techniques as "auxiliary" (ouchi-gari, seoi-nage, osoto-gari, and tani-otoshi). In our sample uchi-mata is also pointed out as "basic", but all the other techniques sorted as auxiliary didn't match (uchi-mata-sukashi, sumi-otoshi and sode-tsurikomi-goshi). Furthermore, techniques that we classified as second, third and fourth most efficient technique are not in the top ten most efficient techniques in the previously cited articles. A possible explanation is a difference in the sample used (national vs high-level international athletes), but we hypothesize that the judo combat has shifted to a more defensive state since the auxiliary techniques uchi-mata-sukashi and sumi-

otoshi are used to counter unsuccessful attack of the opponent.

The present results demonstrated the technical-tactical profile of the elite athletes in the under 90kg category. Te-waza and ashi-waza are dominant, followed by sutemi-waza and koshi-waza. When comparing the World's best judokas (top ten) and other elite judokas, it is necessary to point out that the top 10 judokas use more koshi-waza and less sutemi-waza. Individual techniques used for scoring in the fight are uchi-mata, uchi-mata-sukashi, sumi-otoshi and sode-tsurikomi-goshi.

Conclusion

The underlying findings from this study are the information about the course of the fight in the under 90kg category. Attacking activity is highest in the second minute, but the effectiveness of the attack is highest in the last, fourth minute of the fight. Uchi-mata and sode-tsurikomi-goshi are the main attacking techniques accompanied by te-waza techniques (uchi-mata-sukashi, sumi-otoshi) used commonly to punish the opponent's mistake. Elite competitors' dominance is characterized by more frequent use of koshi-waza, compared to their less successful counterparts who use sutemi waza more often. The fact that we analyze only one weight category can be a strength and, at the same time, limitation of this study. Therefore, coaches and analysts can value the information provided since it is category-specific, and make extensive use of it in the technical and tactical preparation for the high-level competitions.

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