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KINESIOLOGY & COACHING

Kiyoshi Ito[1 (ABCDEF)], Toshihiro Takezawa[2 (ADEF),] Nobuyoshi Hirose[3 (ABCDE)]
1 ORCID:https://orcid.org/0000-0002-4168-9372
Fuji University, Faculty of Economics, Iwate (Japan)
2 ORCID:https://orcid.org/0000-0001-8040-4387
Juntendo University, Graduate School of Health and Sports Science, Chiba (Japan)
3 ORCID: https://orcid.org/0000-0002-8782-8665
Juntendo University, Graduate School of Health and Sports Science, Chiba (Japan)
Corresponding author: Kiyoshi Ito, Kyushukyoritsu University, Faculty of Sports Science, 1-8, Jiyugaoka, Yahatanishi-ku, Fukuoka, 807-8585 Japan, e-mail: kiyoshi@kyukyo-u.ac.jp, phone: +81-93-693 -3316

Effective tactical actions preceding scored throws categorized by weight category in international-level judo competitions

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Abstract
Background. Many previous studies have been conducted from multiple perspectives with the aim of improving performance to contribute to victory in judo. In recent years, these studies not only investigated the types and numbers of effective throws from official data but also analyzed the performance of throwing techniques including gripping configurations.
Problem and aim. The purpose of this study is to clarify the most effective tactical pattern preceding scored throws in judo throwing techniques.
Material and Methods. The video of 705 contests became the research target material. Six hundred eighty-five scored throws and gripping techniques preceding the scored throws were analyzed. *Chi*-square tests were used to verify any association between the independent variables (cross-grip, regrip, grip target, and rotational throw) and the dependent variable (score earned by throwing technique). The most effective pattern was elucidated by creating a flowchart including 36 tactical action patterns.
Results. Using a two-handed grip, without using the cross grip and the regrip, gripping the collar and sleeve(s), and then performing a rotational throw was found to be the most effective tactical pattern in many weight categories. In addition, we confirmed the relationship between consecutive tactical steps in two-handed attacks. It became clear that a rotational throw when gripping the collar and the sleeve(s), and a non-rotational throw when gripping the dorsal region with at least one hand were effective.
Conclusions. We could obtain data from different perspectives. By associating the multiple data points from different perspectives, coaches can give competitors more focused advice on tactics in each weight category.

Introduction

Many previous studies have been conducted from multiple perspectives with the aim of improving performance to contribute to victory in judo. In recent years, these studies not only investigated the types and numbers of effective throws from official data but also analyzed the performance of throwing techniques including gripping configurations.

Gripping (*kumi kata*) constitutes a very important segment of judo competitions, and well-executed gripping techniques may be a key factor in the outcomes of

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competitions [Kajimovic *et al*. 2014]. One of the most important actions in winning or losing is the moment of the gripping, indeed, 59.3% of the effort sequences were comprised of either "trying gripping time" or "accomplished gripping time" [Soriano *et al*. 2019]. Approach and handgrip phases make up a large part of the total competition time, and have become extremely important for competitive performance [Barreto *et al*. 2019]. Two-thirds of competition time in the men's and women's finals of the 2016 Rio de Janeiro Olympics were spent on activities other than offense or defense maneuvers [Boguszewski 2016]. This result suggests the remainder of the time was, to some extent, used in different activities related to gripping techniques, such as competitors considering how to approach and grab their opponent and attempting to gain an advantage over their opponent once gripping had commenced. Gold medal winners presented higher variation for grip and actions before attack compared to bronze medalists in the World Championships [Agostainho, Franchini 2021]. The most efficient throwing technique for men considering the same side grip is *ippon-seoi-nage*, while for women it was the *harai-goshi*. In the opposite side grip, *uchi-mata* is the most efficient technique for both men and women [Kajmovic *et al*. 2014]. Mayo *et al*. [2019] reported that there was an association between the lateral structure of fighting (symmetrical or asymmetrical position) and the category of techniques. Scoring rates significantly increased when competitors regripped their opponents in *ai-yotsu* and *kenka-yotsu* as well in the total of both stances [Ito *et al*. 2014; Ito *et al*. 2015] after the 2013 IJF (International Judo Federation) rule revision.

Morphologically, athletes could be grouped into four weight divisions: from -60kg and -66kg; -73kg and -81kg; -90kg and -100kg, and +100kg [Franchini *et al*. 2014]. Gutierrez-Santiago, *et al*. [2019] clarified that competitors who score points have few penalties, and the players who cannot score points have many penalties, focusing on the 73 kg weight class in an observational study. The types of penalties, attack patterns, and techniques differ depending on the weight class [Shavkatovich 2020]. Lighter athletes are the most differentiated because they spend more time in the approach phase of attacking, making handgrip attempts, and when performing handgrip attempts, they employ greater gripping diversity. Heavier weight categories spend a longer time in the handgrip phase and utilize more defensive grips [Barreto L.B.M *et al*. 2019]. In male competitions, competitors in lightweight categories spend more time in the approach, and extra lightweight spends less time with the *judogi* gripping; therefore, training focused on approach speed and gripping is recommended for competitors in the lighter categories [Diaz-De-Durana *et al*. 2018]. Approach and gripping strategies are the main discriminant indicators of performance in half-middleweight male judo athletes [Miarka *et al*. 2016]. Regripping prior to throwing resulted in a significantly higher score rate in the men's 100 kg weight category while a significantly higher score rate was achieved by competitors who did not attempt to regrip their opponent prior to throwing them in the women's 52 kg weight category after the 2013 IJF rule revision [Ito *et al*. 2017]. Applications of standing techniques vary by weight category and gender [Martins *et al*. 2019]. Clarifying the differences in gripping techniques by weight category could contribute to improving the accuracy of the following throws.

We presume that a high-level gripping technique preceding the execution of a throwing technique is a prerequisite for scoring in international-level judo competitions, even if the level of the throwing technique itself is high, a score cannot be obtained unless the grip technique is better than that of the opponent. The purpose of this study is to clarify the most effective tactical pattern from the beginning of gripping techniques to scored throws by creating tactical flow charts including 36 tactical patterns in each weight category, and to verify the relationship between consecutive tactical steps in two-handed attacks. Complementing both the data shown in the flowcharts and that shown in the consecutive tactical steps obtained from different approaches in this study could prove valuable insight for more effective coaching.

Methods

Sample

A total of 721 contests, including 369 men's contests from the Grand Slam Paris 2016 (06-07.Feb2016) and 352 men's contests from Grand-Prix Dusseldorf 2016 (19-21.Feb2016), were analyzed using Digital Versatile Discs (DVDs) recorded by the All Japan Judo Federation Reinforcement Committee Science and Research Department.

Sixteen contests that were incompletely recorded and interfered with the analysis were excluded from the study. As a result, the video of 705 contests became the research target material. Six hundred eighty five scored throws and gripping techniques preceding the scored throws were analyzed. There were 84 participating countries in Grand Slam Paris 2016 and 79 in Grand-Prix Dusseldorf 2016 [International Judo Federation 2019].

Ethics

There are no ethical issues in analyzing or interpreting this data obtained in secondary form. The data was not obtained from human experimentation. Additionally, contestants' personal information was not reported, as

only the number of scores for each weight category in the competitions was analyzed.

Design

This research is a descriptive and cross-sectional study. As a descriptive analysis, each flowchart includes 36 tactical patterns preceding scored throws for each weight category and the total between all weight classes is shown. Each tactical pattern consists of 5 actions (Step 1: grip number, Step 2: cross-grip, Step 3: regrip, Step 4: grip-target, Step 5: rotational throw). This gives a bird's-eye view of the flow of tactics from the beginning of the gripping techniques to a scored throw. In addition, we found the relationships between consecutive tactical actions (Step 2-3, Step 3-4, and Step 4-5, excluding Step 1-2) in a two-handed attack for each weight category and the total for all categories, and confirmed the effective tactical associations between the Steps.

Determination of Variables

The five variables affecting scored throws were Step 1: grip number, Step 2: cross-grip or non-cross-grip, Step 3: regrip or no regrip, Step 4: grip targets (Table 1) and Step 5: rotational throw or non-rotational throw [Adam *et al*. 2011].

The definitions of the variables are as follows.

Step 1: Grip number – use of a single hand (OHG: one-handed grip) or two hands (THG: two-handed grip) in their grips preceding a scored throw.

Step 2: Cross-grip – in the beginning of gripping each other, grabbing an opponent by using the opposite side of a judo jacket or a body part, usually extending an arm diagonally, was categorized as a cross-grip technique (CRS).

Non-cross-grip – in the beginning of gripping each other, grabbing an opponent by using the same side of a judo jacket or a body part, usually extending an arm straight forward, was categorized as a non-cross-grip technique.

Step 3: Regrip – a gripping technique preceding a scored throw was considered to include a regripping attempt if the competitor released their opponent with either hand and grabbed their opponent again with the same hand without a break in sparring. Thus, a gripping technique that included more than two instances of a competitor grabbing their opponent in a continuous sequence was categorized as a regrip (RE).

No regrip – a gripping technique in which grasping occurred less than three times was considered to be a gripping technique with no regripping (N-RE).

Step 4: Grip target – the category of gripping targets is shown in the following Table 1.

Step 5: Rotational throw – executing techniques with their body rotating, facing their back or hip to around the opponent's chest and belly, was categorized as a rotational throw (RT); for example, the throwing techniques of *seoi-nage, tai-otoshi* and *harai-goshi* were included [Adam *et al*. 2011; Daigo 2005]. Non-rotational throw – a scored throw without their body rotating (N-RT); for example, the techniques of *o-soto-gari, o-uchi-gari,* and *ko-soto-gari* were included.

Analysts

The first author and one of the co-authors analyzed the data. One of the analysts is 5th *dan*, and the other analyst is 6th *dan*. One analyst has more than 20 years of *judo* coaching experience and the other has more than 40 years of experience. In addition to this, one analyst has more than 10 years of judo competition analysis experience and the other has more than 30 years of experience.

Procedure

One analyst watched the video of 705 contests with the following functions: reverse viewing, slow-motion (0.5x, 0.75x) and high-speed viewing (2.0x), 10-second fast forward and rewind, pause, repeated viewing for seconds and zoom up, and made technical judgments on the above-mentioned five variables. The same analyst randomly selected 176 competitions, which is 25% of the total number of the 705 contests that the analyst watched, and re-watched them with the same viewing method. The concordance rate was 95% or more; therefore, the intra-rater reliability was confirmed. The other analyst watched 26 contests randomly selected, which is 15% of the 176 contests that were watched again, and the concordance rate between the two analysts was 95% or more. Therefore, inter-rater reliability was confirmed. We determined that the data are sufficiently reliable and valid. As a result, the score of 685 throwing techniques was confirmed. Videos of 685 scored throws (*yuko, waza-ari,* and *ippon*) and the preceding gripping techniques were analyzed. Tactical actions divided into 5 Steps from the beginning of gripping techniques to scored throws were coded using Microsoft Excel software.

Statistics

Chi-square tests were used to verify any association between the independent variables (cross-grip, regrip, grip target, and rotational throw) and the dependent variable (score earned by throwing technique). Residual analysis was performed as a subtest. *Phi* coefficient and Cramer's *V* were calculated to evaluate effect size in each test and interpreted using the following criteria: small-effect size; 0.00 to 0.30, medium-effect size; 0.31 to 0.50, large-effect size; 0.51-1.00. When the tests with degrees of freedom equal to 1 and the expected frequency of less than 5 were confirmed at 20% or more, Fisher's

Table 1. Classification of the grip targets preceding scored throws.

Grip number	Gripping categories	Abbr.	Gripping targets
One-handed grip	Collar	C	Collar
	Sleeve	S	Sleeve
	Others	O1	Places other than Collar, Sleeve, and Dorsal region.
Two-handed grip	Collar and Sleeve(s)	C&S	Collar & Sleeve, Collar & Collar, Sleeve & Sleeve.
	Dorsal region	D	Dorsal region & Dorsal region, Dorsal region & Collar, Dorsal region & Sleeve, Dorsal region & Others.
	Others	O2	Collar or Sleeve and the place other than Collar, Sleeve, and Dorsal region;
			Places other than Collar, Sleeve, and Dorsal region.

exact probability test was used to calculate exact significance. The statistical significance level was set at 5% for all analyses. The Statistical Package for Social Science (SPSS) base 21.0 for Windows was used to compute the statistics.

Results

Figure 1 shows the flows of tactical patterns in which a score was obtained with a one-handed grip and the flows of tactical patterns in which the score was obtained with a two-handed grip according to the total score number of all 7 weight categories. It is a flowchart for evaluating the five consecutive tactical actions from a bird's-eye view by dividing them into 36 tactical patterns. There were 12 tactical patterns with one-handed grips and 24 tactical patterns with two-handed grips.

As Figure 1 shows, the two-handed attack had the highest score ratio for rotational throws using the collar and sleeve(s) without a cross-grip and a regrip (n=98, 14.3%; T2-19) in the total score number of all 7 weight categories. In this pattern, hand techniques were used the most, of which the *seoi-nage* was used the most. Thirteen types of throwing techniques were confirmed (hand: 49, *seoi-nage*: 28; Table 2). On the other hand, in the one-handed attack, the score ratio by rotational throws using the collar without a cross-grip was the highest (n=24, 3.5%; T1-7). In this pattern, hand techniques were used the most, of which the *ippon-seoi-nage* was used the most. Six types of throwing techniques were confirmed (hand: 20, *ippon-seoi-nage*: 15; Table 2).

Figure 2 shows the flow of tactical patterns in the extra-lightweight category. The two-handed attack had the highest score ratio for non-rotational throws using the collar and sleeve(s) without a cross-grip and a regrip (n=17, 15.0%; EL2-20). In this pattern, leg techniques were used the most, of which the *o-soto-gari* and *ko-soto-gari* were used the most. Eleven types of throwing techniques were confirmed (leg: 9, *o-soto-gari*: 3 and *ko-soto-gari*: 3; Table 2). On the other hand, in the one-handed attack, the score ratio by rotational throws using the collar without a cross grip was the highest (n=8, 7.1%; EL1-7). In this pattern, hand techniques were used the most, of which the *ippon-seoi-nage* was used the most. Three types of throwing techniques were confirmed (hand: 7, *ippon-seoi-nage*: 6; Table 2).

Figure 3 shows the flow of tactical patterns in the half-lightweight category. The two-handed attacks had the highest score ratio for rotational throws using the collar and the sleeve(s) without a cross-grip and a regrip (n=8, 9.6%; HL2-19), non-rotational throws using the dorsal region area without a cross-grip and a regrip (n=8, 9.6% ; HL2-22), and non-rotational throws using any places other than the collar, sleeve(s) and the dorsal region area, at least one hand without a cross-grip and a regrip (n=8,9.6%;HL2-24). In the pattern indicated by HL2-19, hand techniques were used the most, of which the *seoi-nage* was used the most. Four types of throwing techniques were confirmed (hand: 6, *seoi-nage*: 4; Table 2). In the pattern indicated by HL2-22, leg techniques were used the most, of which the *ko-soto-gake* was used the most. Seven types of throwing techniques were confirmed (leg: 5, *ko-soto-gake:* 2; Table 2). In the pattern indicated by HL2-24, sacrifice techniques were used the most, of which the *sumi-gaeshi* was used the most. Seven types of throwing techniques were confirmed (sacrifice: 4, *sumi-gaeshi*: 2; Table 2). On the other hand, in the one-handed attack, the score ratio by rotational throws using the collar without a cross-grip was the highest (n=5, 6.0%; HL1-7). In this pattern, hand techniques were used the most, of which the *seoi-nage* was used the most. Two types of throwing techniques were confirmed (hand: 5, *seoi-nage*: 3; Table 2).

Figure 4 shows the flow of tactical patterns in the lightweight category. The two-handed attack had the highest score ratio for both rotational throws (n=24, 17.5%; L2-19) and non-rotational throws (n=24, 17.5%; L2-20) using the collar and sleeve(s) without a cross-grip and a regrip. In the former pattern shown by index L2-19, hand techniques were used the most, of which the *seoi-nage* was used the most. Six types of throwing techniques were confirmed (hand: 14, *seoi-nage*: 8; Table 2). In the latter pattern shown by index L2-20, leg techniques were used the most, of which two leg techniques, the *ko-soto-gari* and the *ko-uchi-gari* were used the most. Eleven types of throwing techniques were confirmed (leg: 15, *ko-soto-gari*: 4, *ko-uchi-gari*: 4;

Table 2. Scored throwing techniques that follow the most effective tactical patterns in each weight category.

			Step 2	Step 3	Step 4	Step 5			Hand	Leg	Hip	Sacrifice		Most used scored throws
Weight category	n	Index	Cross-grip	Regrip	Grip targets	Rotational throw	n	%	n				N-types	
Two-handed														
Total	624	T2-19	N-CRS	N-RE	C&S	RT	98	14.3	49	22	20	7	13	*Seoi-nage* 28 (CS11, OP17)
Extra-light	100	EL2-20	N-CRS	N-RE	C&S	N-RT	17	15.0	4	9	0	4	11	*O-soto-gari* 3 (CS1, OP2), *Ko-soto-gari* 3 (CS2, OP1)
Half-light	69	HL2-19	N-CRS	N-RE	C&S	RT	8	9.6	6	1	1	0	4	*Seoi-nage* 4 (OP4)
		HL2-22	N-CRS	N-RE	D	N-RT	8	9.6	2	5	0	1	7	*Ko-soto-gake* 2 (OP2)
		HL2-24	N-CRS	N-RE	O2	N-RT	8	9.6	1	3	0	4	7	*Sumi-gaeshi* 2 (CS2)
Light	128	L2-19	N-CRS	N-RE	C&S	RT	24	17.5	14	6	3	1	6	*Seoi-nage* 8 (CS3, OP5)
		L2-20	N-CRS	N-RE	C&S	N-RT	24	17.5	5	15	0	4	11	*Ko-soto-gari* 4 (CS4), *Ko-uchi-gari* 4 (CS1, OP3)
Half-middle	124	HM2-19	N-CRS	N-RE	C&S	RT	24	18.5	12	3	6	3	8	*Seoi-nage* 6 (CS2, OP4)
Middle	65	M2-19	N-CRS	N-RE	C&S	RT	13	17.8	6	3	2	2	7	*Seoi-nage* 5 (CS1, OP4)
Half-heavy	89	HH2-20	N-CRS	N-RE	C&S	N-RT	12	12.9	2	8	0	2	9	*Ko-soto-gari* 3 (CS2, OP1)
Heavy	49	H2-19	N-CRS	N-RE	C&S	RT	10	17.9	3	5	1	1	5	*Uchi-mata* 5 (OP5)
One-handed														
Total	61	T1-7	N-CRS	-	C	RT	24	3.5	20	1	1	2	6	*Ippon-seoi-nage* 15 (CS7, OP8)
Extra-light	13	EL1-7	N-CRS	-	C	RT	8	7.1	7	0	0	1	3	*Ippon-seoi-nage* 6 (CS2, OP4)
Half-light	14	HL1-7	N-CRS	-	C	RT	5	6.0	5	0	0	0	2	*Seoi-nage* 3 (OP3)
Light	9	L1-7	N-CRS	-	C	RT	3	2.2	2	0	0	1	3	*Ippon-seoi-nage* 1 (CS1), *Seoi-nage* 1 (CS1) , *Soto-makikomi* 1 (OP1)
Half-middle	6	HM1-7	N-CRS	-	C	RT	3	2.3	2	0	1	0	2	*Ippon-seoi-nage* 2 (CS2)
Middle	8	M1-7	N-CRS	-	C	RT	4	5.5	3	1	0	0	2	*Ippon-seoi-nage* 3 (CS1, OP2)
		M1-8	N-CRS	-	C	N-RT	4	5.5	2	1	0	1	4	*Sumi-otoshi* 1 (CS1), *Kata-guruma* 1 (OP1), *Ko-uchi-makikomi* 1 (OP1), *Deashi-harai* 1 (OP1)
Half-heavy	4	HH1-8	N-CRS	-	C	N-RT	2	2.2	0	2	0	0	2	*O-uchi-gari* 1 (OP1), *Ko-uchi-gari* 1 (CS1)
Heavy	7	H1-8	N-CRS	-	C	N-RT	3	5.4	2	1	0	0	2	*Sumi-otoshi* 2 (CS1, OP1)

N-types: number of types; N-CRS: using non-cross-gripping; N-RE: using no regripping (two grips); C&S, D, O2, and C: refer to Table 1;

RT: using rotational throws, N-RT: using non-rotational throws; CS: closed stance, OP: open stance .

Table 2). On the other hand, in the one-handed attack, the score ratio by rotational throws using the collar without a cross-grip was the highest (n=3, 2.2%; L1-7). In this pattern, hand techniques were used the most, *ippon-seoi-nage, seoi-nage and soto-makikomi* were used. Three types of throwing techniques were confirmed (hand: 2; Table 2).

Figure 5 shows the flow of tactical patterns in the half-middleweight category. The two-handed attack had the highest score ratio for rotational throws using the collar and sleeve(s) without a cross-grip and a regrip (n=24, 18.5%; HM2-19). In this pattern, hand techniques were used the most, of which the *seoi-nage* was used the most. Eight types of throwing techniques were confirmed (hand: 12, *seoi-nage*: 6; Table 2). On the other hand, in the one-handed attack, the score ratio by rotational throws using the collar without a cross grip was the highest (n=3, 2.3%; HM1-7). In this pattern, hand techniques were used the most, of which the *ippon-seoi-nage* was used the most. Two types of throwing techniques were confirmed (hand: 2, *ippon-seoi-nage*: 2; Table 2).

Figure 6 shows the flow of tactical patterns in the middleweight category. The two-handed attack had the highest score ratio for rotational throws using the collar and sleeve(s) without a cross-grip and a regrip (n=13, 17.8%; M2-19). In this pattern, hand techniques were used the most, of which the *seoi-nage* was used the most. Seven types of throwing techniques were confirmed (hand: 6, *seoi-nage*: 5; Table 2). On the other hand, in the one-handed attack, the score ratio by both rotational throws (n=4, 5.5%; M1-7) and non-rotational throws (n=4, 5.5%; M1-8) using the collar without a cross-grip was the highest. In the former pattern shown by index M1-7, hand techniques were used the most, of which the *ippon-seoi-nage* was used the most. Two types of throwing techniques were confirmed (hand: 3, *ippon-seoi-nage*: 3; Table 2). In the latter pattern shown by index M1-8, hand techniques were used the most, specifically *sumi-otoshi* and *kata-guruma*. Four types of throwing techniques were confirmed (hand: 2; Table 2).

As Figure 7 shows the flow of tactical patterns in the half-heavyweight category. The two-handed attack had the highest score ratio for non-rotational throws using the collar and sleeve(s) without a cross-grip and a regrip (n=12, 12.9%; HH2-20). In this pattern, leg techniques were used the most, of which the *ko-soto-gari* was used the most. Nine types of throwing techniques were confirmed (leg: 8, *ko-soto-gari*: 3; Table 2). On the other hand, in the one-handed attack, the score ratio by non-rotational throws using the collar without a cross-grip was the highest (n=2, 2.2%; HH1-8). In this pattern, two leg techniques, *o-uchi-gari* and *ko-uchi-gari*, were used (Table 2).

Table 3. Relationship between the consecutive tactical steps in the two-handed attacks categorized by weight category (Step 2-5).

		Step 3: Regrip							Step 4: Grip Target									Step 5: Rotational Throw						
Weight category	Step 2: Cross Grip		RE			N-RE			Step 3: Regrip	C&S			D			O2			Step 4: Grip Targets	RT			N-RT		
		Total	n	%		n	%			Total	n	%	n	%		n	%			Total	n	%		n	%	
		624	255	40.9		369	59.1			624	309	49.5	177	28.4		138	22.1			624	280	44.9		344	55.1	
Total	CRS	147	77	52.4	**	70	47.6		RG	255	77	30.2	105	41.2	***	73	28.6	***	C&S	309	170	55.0	***	139	45.0	
	N-CRS	477	178	37.3		299	62.7	**	N-RG	369	232	62.9	*** 72	19.5		65	17.6		D	177	59	33.3		118	66.7	***
																			O2	138	51	37.0		87	63.0	
Extra-light n=100	CRS	27	16	59.3	**	11	40.7		RG	35	11	31.4	11	31.4		13	37.1		C&S	44	18	40.9		26	59.1	
	N-CRS	73	19	26.0		54	74.0	**	N-RG	65	33	50.8	18	27.7		14	21.5		D	29	15	51.7		14	48.3	
																			O2	27	10	37.0		17	63.0	
Half-light n=69	CRS	16	10	62.5		6	37.5		RG	29	9	31.0	10	34.5		10	34.5		C&S	27	15	55.6		12	44.4	
	N-CRS	53	19	35.8		34	64.2		N-RG	40	18	45.0	10	25.0		12	30.0		D	20	7	35.0		13	65.0	
																			O2	22	5	22.7		17	77.3	
Light n=128	CRS	24	16	66.7	**	8	33.3		RG	53	18	34.0	24	45.3	***	11	20.8		C&S	72	38	52.8	**	34	47.2	
	N-CRS	104	37	35.6		67	64.4	**	N-RG	75	54	72.0	*** 10	13.3		11	14.7		D	34	7	20.6		27	79.4	**
																			O2	22	9	40.9		13	59.1	
Half-middle n=124	CRS	34	10	29.4		24	70.6		RG	50	12	24.0	24	48.0	***	14	28.0	***	C&S	65	39	60.0	*	26	40.0	
	N-CRS	90	40	44.4		50	55.6		N-RG	74	53	71.6	*** 14	18.9		7	9.5		D	38	13	34.2		25	65.8	
																			O2	21	7	33.3		14	66.7	
Middle n=65	CRS	21	10	47.6		11	52.4		RG	22	8	36.4	8	36.4		6	27.3		C&S	35	26	74.3	***	9	25.7	
	N-CRS	44	12	27.3		32	72.7		N-RG	43	27	62.8	7	16.3		9	20.9		D	15	1	6.7		14	93.3	***
																			O2	15	6	40.0		9	60.0	
Half-heavy n=89	CRS	17	10	58.8		7	41.2		RG	42	9	21.4	18	42.9		15	35.7		C&S	37	16	43.2		21	56.8	
	N-CRS	72	32	44.4		40	55.6		N-RG	47	28	59.6	** 10	21.3		9	19.1		D	28	10	35.7		18	64.3	
																			O2	24	13	54.2		11	45.8	
Heavy n=49	CRS	8	5	62.5		3	37.5		RG	24	10	41.7	10	41.7		4	16.7		C&S	29	18	62.1		11	37.9	
	N-CRS	41	19	46.3		22	53.7		N-RG	25	19	76.0	3	12.0		3	12.0		D	13	6	46.2		7	53.8	
																			O2	7	1	14.3		6	85.7	

CRS: using cross-gripping, N-CRS: using non-cross-gripping; RG: using regripping (three or more grips without interruption), N-RG: using no regripping (two grips);
C&S, D, and O2: refer to Table 1; RT: using rotational throws, N-RT: using non-rotational throws. *p<.05. **p<.01. ***p<.001.

Figure 8 shows the flow of tactical patterns in the heavyweight category. The two-handed attack had the highest score ratio for rotational throws using the collar and sleeve(s) without a cross-grip and a regrip (n=10, 17.9%; H2-19). In this pattern, leg techniques or the *uchi-mata* were used the most. Five types of throwing techniques were confirmed (leg: 5, *uchi-mata: 5*, Table 2). On the other hand, in the one-handed attack, the score ratio by non-rotational throws using the collar without a cross-grip was the highest (n=3, 5.4%; H1-8). In this pattern, hand techniques or *sumi-otoshi* were used the most. Two types of throwing techniques were confirmed (hand: 2, *sumi-otoshi*: 2; Table 2).

Because the number of scored throws from a two-handed grip was overwhelmingly higher than that of one-handed grips in the total score number of all 7 weight categories (OHG: n=61, 8.9%; THG: n=624, 91.1%; Figure 1), we decided to analyze the relationship between the consecutive tactical actions preceding the scored throws from only two-handed grips (Step 2-3, Step 3-4, Step 4-5; Table 3).

Focusing on the relationship between Tactical Step 2 and Step 3, as Table 3 contains, the score ratio of using a regrip when using a cross-grip was significantly higher, while using a no-regrip when using the non-cross-grip was significantly higher in the total score number of all 7 weight categories, the extra-lightweight and the light-weight categories (χ^2=10.553, *df*=1, *p*=0.001,φ=0.130; χ^2=9.568,*df*=1, *p*=0.002, φ=0.309: χ^2=7.769,*df*=1, *p*=0.005,φ=0.246; respectively).

Focusing on the relationship between Tactical Step 3 and Step 4, as Table 3 contains, the score ratio of using the collar and sleeve(s) (C&S) without a regrip was significantly higher, while using the dorsal region (D) or the others (O2) after using a regrip was significantly higher in the total score number of all 7 weight categories and the half-middleweight category (χ^2=65.734, *df*=2, *p*=0.000, Cramer'*v*=0.325; χ^2=27.200, *df*=2, *p*=0.000, Cramer'*v*=0.468; respectively).

The score ratio of using the collar and sleeve(s) (C&S) without a regrip was significantly higher, while using the dorsal region (D) after using a regrip was significantly higher in the lightweight category (χ^2=20.592, *df*=2, *p*=0.000, Cramer'*v*=0.401). The score ratio of using the collar and sleeve(s) (C&S) without a regrip was significantly higher in the half-heavyweight category (χ^2=13.304, *df*=2, *p*=0.001, Cramer'*v*=0.387).

Focusing on the relationship between Tactical Step 4 and Step 5, as Table 3 contains, the score ratio of rotational throws using the collar and sleeve(s) (C&S) was significantly higher, while non-rotational throws using the dorsal region (D) were significantly higher in the total score number of all the 7 weight categories, the light and the middleweight categories (χ^2=25.876, *df*=2,

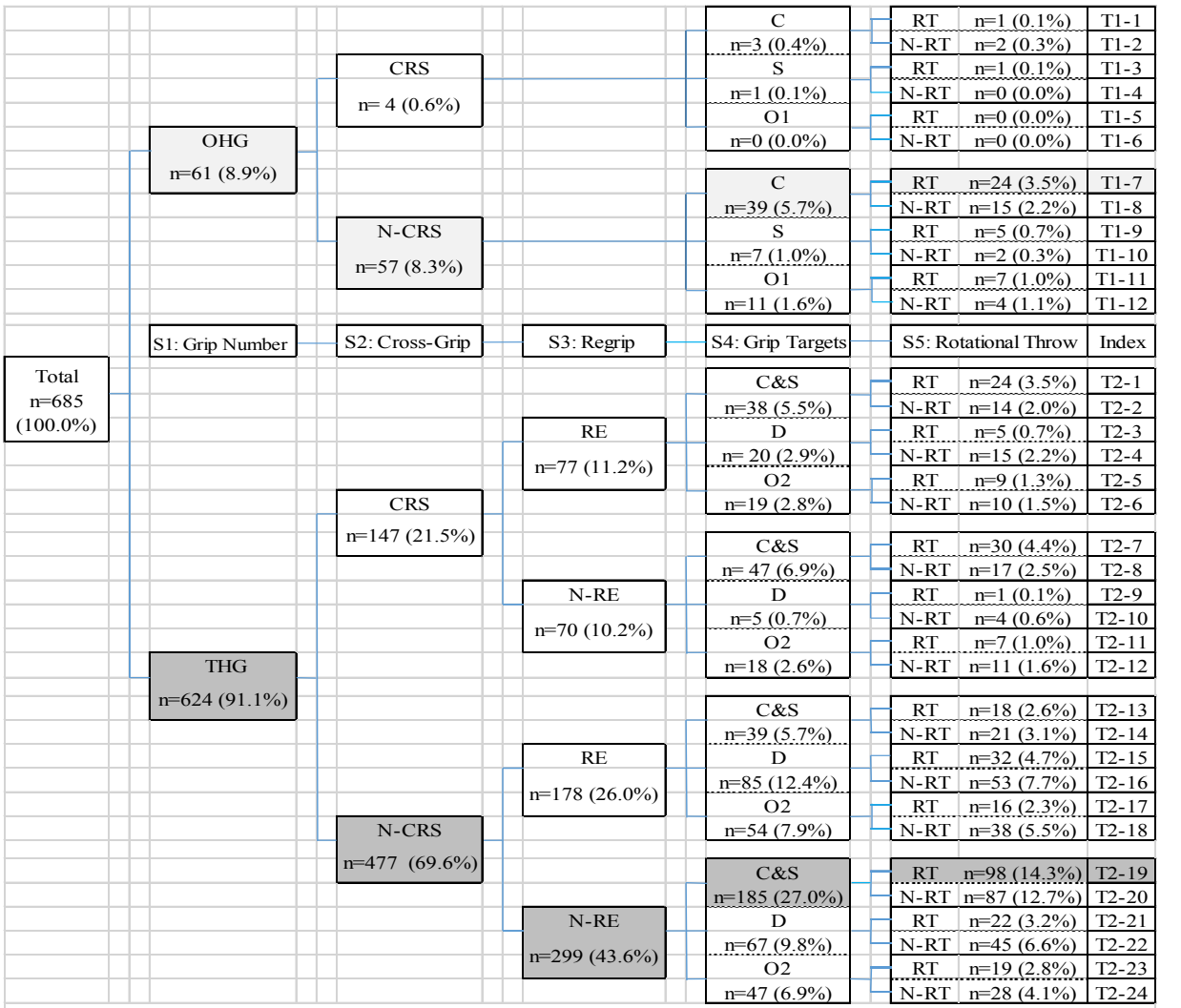

Figure 1. The flow chart of tactical patterns preceding the scored throws in all the 7 weight categories.

S1:Step1,S2:Step2,S3:Step3,S4:Step4,S5:Step5; OHG: one-handed grip,THG: two-handed grip; CRS: using the cross-grip, N-CRS: using non-cross-grip; RG: using the regrip (three or more grips without interruption), N-RG: using no regrip (two grips); C, S, O1, C&S, D, and O2: refer to Table 1; RT: using the rotational throw, N-RT: using non-rotational throw . The cells indicating the most effective tactical pattern is grayed out in two-handed attacks. The cells indicating the most effective tactical pattern is light gray in one-handed attacks.

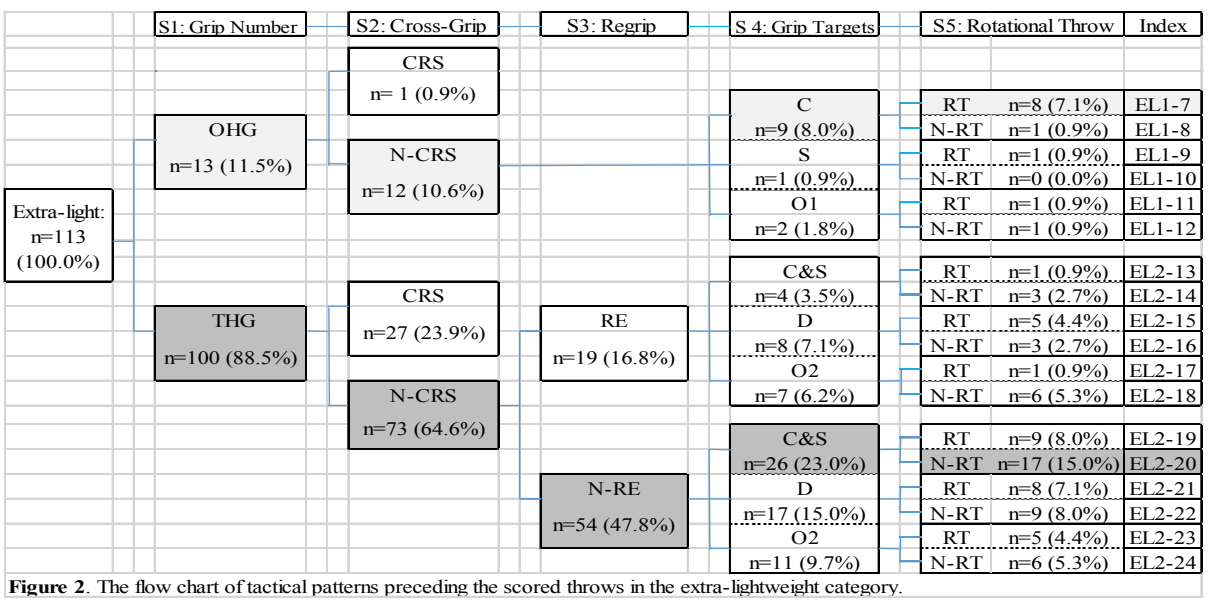

Figure 2. The flow chart of tactical patterns preceding the scored throws in the extra-lightweight category.

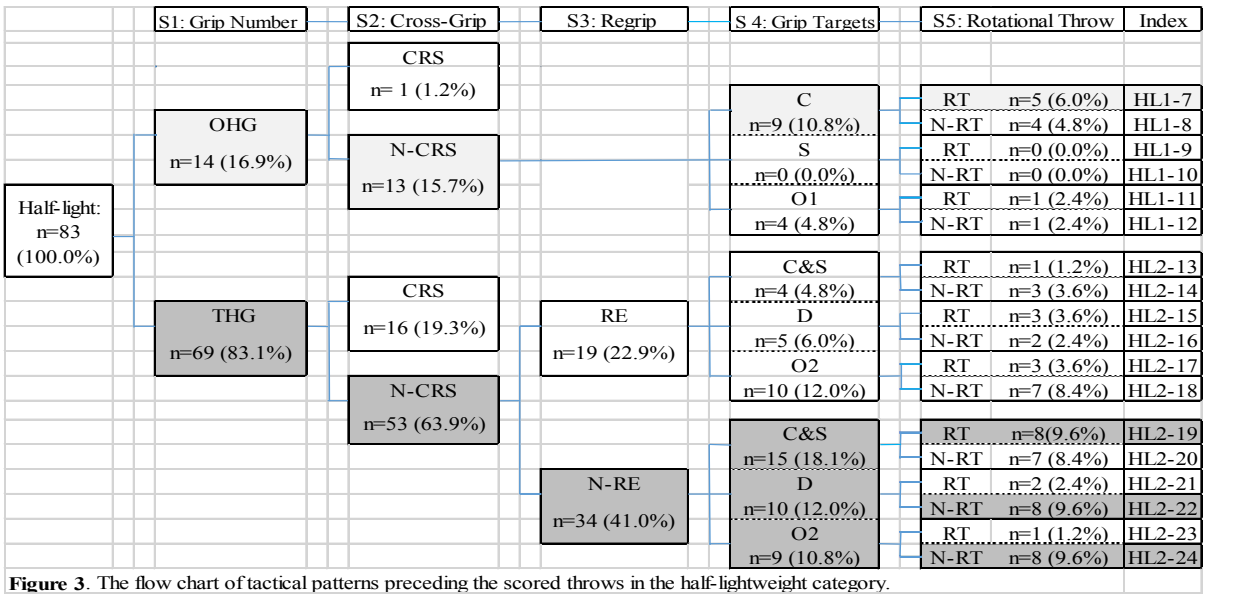

Figure 3. The flow chart of tactical patterns preceding the scored throws in the half-lightweight category.

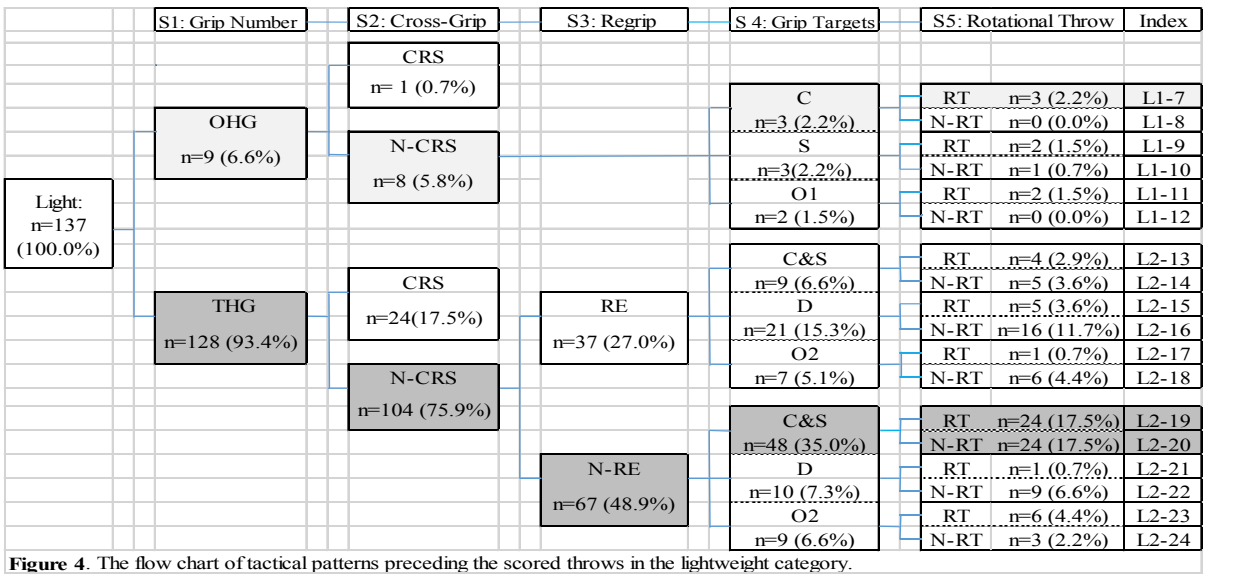

Figure 4. The flow chart of tactical patterns preceding the scored throws in the lightweight category.

p=0.000, Cramer'v=0.204; χ^2=9.829, df=2, p=0.007, Cramer'v=0.277; χ^2=20.113, df=2, p=0.000, Cramer'v=0.556; respectively). The score ratio of rotational throws using the collar and sleeve(s) (C&S) was significantly higher in the half-middleweight category (χ^2=8.452, df=2, p=0.015, Cramer'v=0.261).

Discussion

First, it turned out that two-handed attacks were more effective than one-handed attacks.

Considering that the score ratio for one-handed attacks is 8.9%, we insist that coaching for two-handed attacks is more important. Kashiwagura D.B. *et al.* [2021] insist that when attacking, grips performed with one hand should be avoided as they are unlikely to result in a score, which is supported by our findings. The reason for the low score ratio for one-handed attacks is that the 2013 IJF competition rule was changed to prohibit attacks with hands and arms under the belt. As a result, competitors can no longer use the *kibi-su-gaeshi* and *kuchiki-taoshi* that can be executed with one hand [Ito *et al.* 2014]. In other words, the reason why the score ratio for one-handed attacks was low is that throwing techniques performed with one hand cannot be used due to the penalties introduced by the 2013 IJF competition rule.

An effective tactical pattern with a two-handed grip has been revealed. Up to the 4 Steps (grip targets) of the tactical actions, the most effective tactical flow was the same for all weight categories as follows, S1: THG, S2: N-CRS, S3: N-RG, & S4: C&S. This suggests that an effective tactical flow regardless of weight category could exist. Including up to Step 5 (rotational throw), the score ratio by the technique with rotational

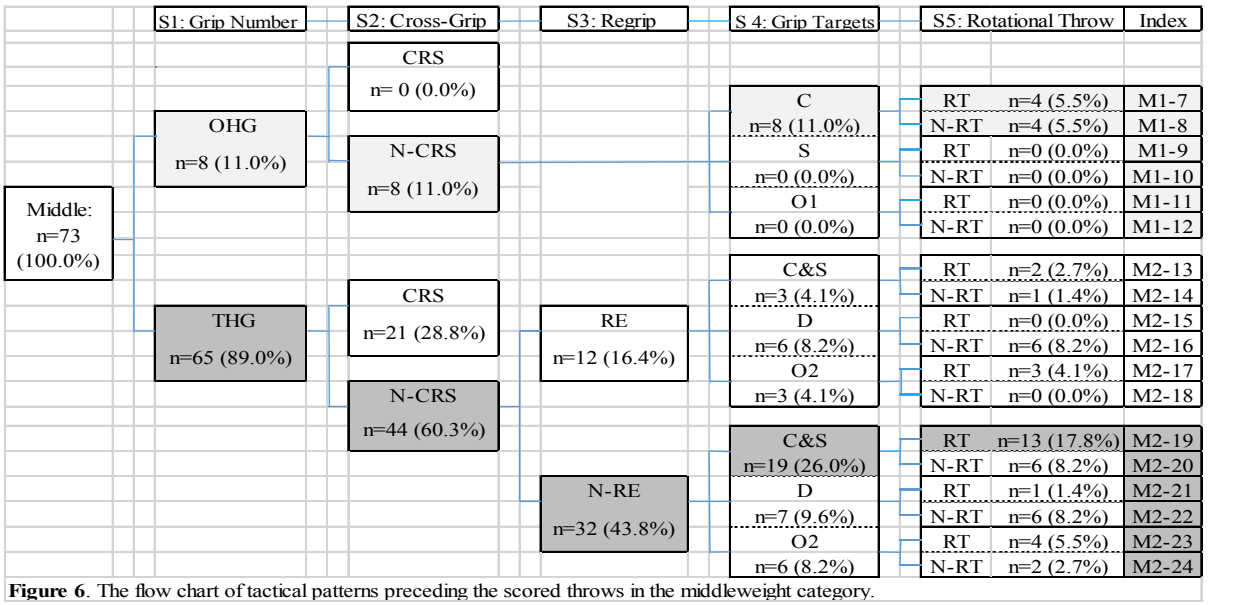

Figure 6. The flow chart of tactical patterns preceding the scored throws in the middleweight category.

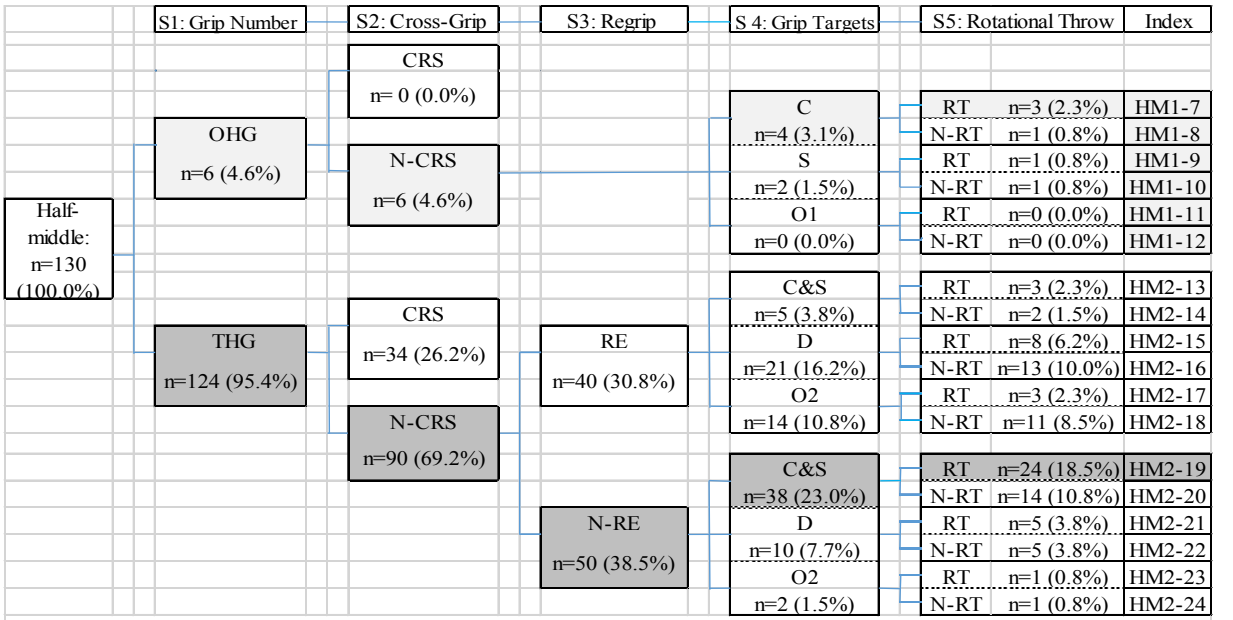

Figure 5. The flow chart of tactical patterns preceding the scored throws in the half-middleweight category.

throws is the highest in the 5 weight categories excluding the extra-lightweight and the half-heavyweight categories. We presume that the following tactical flow, S1: THG, S2: N-CRS, S3: N-RG, S4: C&S, & S5: RT, is the most effective action for getting a score with a throwing technique in men's senior international competitions.

Focusing on one-handed attacks, the tactical actions included in using the collar without a cross-grip had the highest score ratio for all 7 weight categories up to 4 Steps (there is no 3-Step in one-handed attacks). This result suggests that the options for one-handed attack methods are limited. Considering up to 5 Steps, the score ratio of rotational throws was higher than the non-rotational throws in the 5 weight categories excluding the half-heavy and the heavyweight categories. In other words, it became clear that in one-handed attacks, rotational throws using the collar without a cross-grip are standard. Considering that lower score ratio, limited tactical actions, and some techniques have disappeared due to the above-mentioned rule change, it is difficult for competitors to increase their score ratio using one-handed attacks.

In studying the association between effective tactical patterns and scored throws with a two-handed grip, we found that hand techniques, specifically *seoi-nage,* is particularly effective in tactical patterns including rotational throws. (for the half-light, the light, the half-middle, and the middleweight categories, and the total; Table 2). The reason for this is that there is room for improvement in

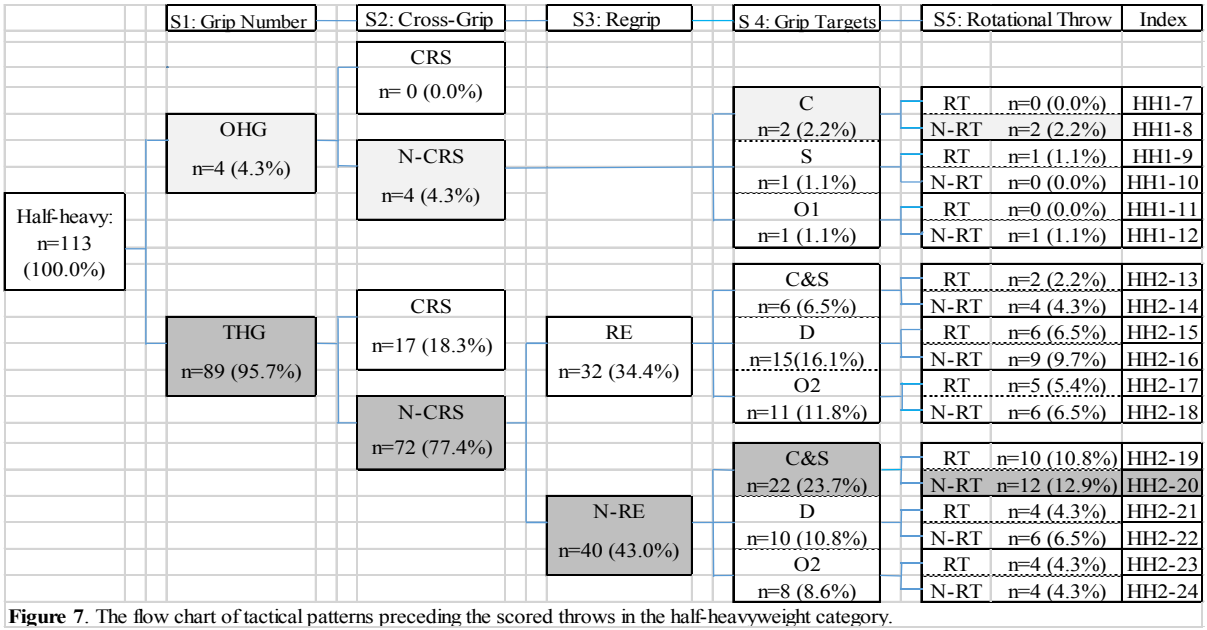

Figure 7. The flow chart of tactical patterns preceding the scored throws in the half-heavyweight category.

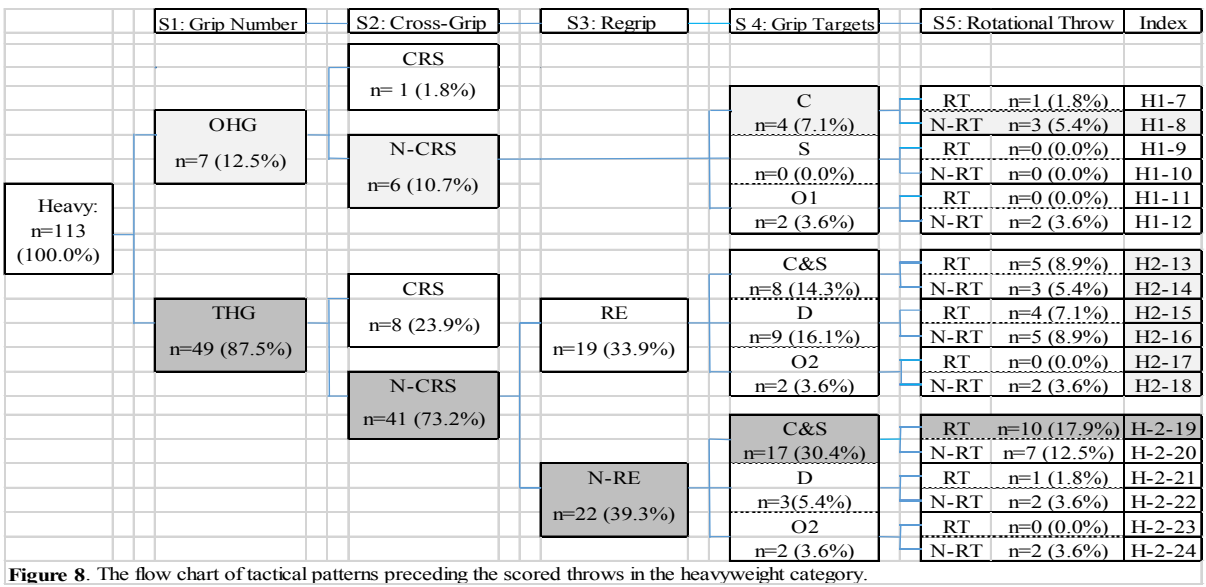

Figure 8. The flow chart of tactical patterns preceding the scored throws in the heavyweight category.

seoi-nage. We can find that a new type of *seoi-nage* is being developed.

On the other hand, leg techniques throwing backward, *o-soto-gari, ko-soto gari, ko-soto-gake,* and *ko-uchi-gari* are effective (for the extra-light, the half-light, the light, and the half-heavyweight categories; Table 2) in tactical patterns including non-rotational throws. In leg techniques, backward throwing techniques could be effective in scoring in these weight categories. However, in the heavyweight category, *uchi-mata* or a forward throwing technique, is effective in scoring. This weight category is unique in that regard. Sterkowicz-Prezybycien *et al.* [2017] support our research finding, stating that the lightest and heaviest judo athletes displayed unique characteristics compared with athletes in other weight categories, particularly in the attack, defense, groundwork, and pause phases.

With one-handed grips, hand techniques, specifically *ippon-seoi-nage* is effective in tactical patterns including rotational throws. (for the half-light, the light, the half-middle, and the middleweight categories, and the total; Table 2). *Sumi-otoshi* is effective in tactical patterns including non-rotational throws (for the middle and the heavyweight categories; Table 2).

However, as mentioned above, the tactics for one-handed techniques are limited and the resulting score ratio is low.

As Table 3 shows, a significant relationship was found between tactical actions in all other categories except the half lightweight and the heavyweight categories. In this study, it is difficult to clarify why only these two weight categories had no significant relationship.

The significantly high score ratio while using a non-cross-grip (Step 2) and no regrip (Step 3) means that the

competitors chose the standard gripping or simple and time-saving gripping so that they would not be penalized due to the passive attacks in the match.

In terms of the relationship between the regrip (Step 3) and the grip target (Step 4), competitors can easily grab the collar and sleeve(s) (C&S) because these grip targets are located in front of the body. On the other hand, it is very important to regrip when attempting to grab the dorsal region (D) and other parts (O2) that are relatively far apart. In other words, there is no need for regripping when grabbing the collar and sleeve(s) (C&S), and it is conceivable that using a regrip will be effective when grabbing the dorsal region (D) or other parts (O2). Kashiwagura D.B *et al*. [2021] clarify that grabbing the dorsal region is decisive in differentiating the effectiveness of the attack systems. We assume increasing the accuracy of the regrip technique will make it easier to grab the opponent's dorsal, and it is conceivable that grabbing the dorsal will increase the score ratio.

Regarding the relationship between the grip targets (Step 4) and rotational throws (Step 5), rotational throws are effective when using the collar and sleeve(s) (C&S), and non-rotational throws (N-RT) are effective when grabbing the dorsal region (D). It is thought that this is because rotational throws (RT) require enough space to rotate the body when gripping each other, and non-rotational throws (N-RT) require less space than rotational throws (RT). Therefore, it can be inferred that rotational throws (RT) are effective when grabbing the collar and sleeve(s) (C&S), and non-rotational throws (N-RT) are effective when grabbing the dorsal region (D) because of the close proximity to each other. Kashiwagura D.B. *et al*. [2021] report that grabbing the right sleeve(s) and the left collar resulted in more scores, and attacking towards the forward left while grabbing the right collar and the left sleeve(s) resulted in more scores in forward right attacks. In other words, when competitors grab the collar and sleeve(s), they throw the opponent forward to get the score. Assuming that the technique of throwing forward is a rotational throw, this research report will support our findings.

Focusing on the weight category, a significant relationship was found between all tactical steps (Steps 2-3, Steps 3-4, and Steps 4-5) in the lightweight category, and a significant relationship was also found in Steps 3 and 4, and Step 4 and 5 in the half-middleweight category. Franchini *et al*. [2014] indicate that morphologically, athletes belonging to these two weight categories are grouped in the same division. We assume that competitors in these two weight categories are differentiated from those of other weight categories in tactical actions.

Conclusions

This study reveals that a most effective tactical pattern common to many weight categories exists. For one-handed grips, the rotational throws using the collar without the cross-grip are the most effective tactical action in all other weight categories except the half-heavyweight and the heavyweight categories, while for two-handed grips, rotational throws using the collar and the sleeve(s) without a cross-grip and a regrip are the most effective tactical action in all other weight categories except the extra-lightweight and the half-heavyweight categories. In other words, in either case, it is effective to grip the collar and sleeve(s), which are the basic gripping parts, and use rotational throws.

For two-handed grips, *seoi-nage* and *ko-soto-gari* are recommended as effective throwing techniques that follow the most effective tactical patterns, while for one-handed grips, *ippon-seoi-nage*, *seoi-nage*, and *sumi-otoshi* are recommended. We insist that rather than vaguely showing effective throwing techniques for each weight category, it is a necessary viewpoint for coaching to investigate effective throwing techniques that follow the most effective tactical patterns for each weight category.

In all other weight categories except the half-light and the heavyweight categories, significant relationships between tactical steps were confirmed: a cross-grip and a regrip; a regrip and the grip targets; the grip targets and rotational throws.

By finding the most effective tactical patterns and their most effective throwing techniques, and verifying any association between the independent variables (cross-grip, regrip, grip target, and rotational throw) and the dependent variable (score earned by a throwing technique) for each weight category, we could obtain data from different perspectives. By associating the multiple data points from different perspectives, coaches can give competitors more focused advice on tactics in each weight category.

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Skuteczne działania taktyczne poprzedzające punktowane rzuty z podziałem na kategorie wagowe w międzynarodowych zawodach judo

Słowa kluczowe: sztuki walki, sporty walki, analiza wyników, analiza opisowa, trenerstwo, taktyka

Streszczenie

Tło. Wiele wcześniejszych badań zostało przeprowadzonych z różnych perspektyw w celu poprawy wyników i przyczynienia się do zwycięstwa w judo. W ostatnich latach badania te nie tylko dotyczyły rodzajów i liczby skutecznych rzutów na podstawie oficjalnych danych, ale także analizowały wykonanie technik rzutów, w tym konfiguracje chwytów.

Problem i cel. Celem niniejszego badania było wyjaśnienie najbardziej skutecznego wzorca taktycznego poprzedzającego punktowane rzuty w technikach rzutów w judo.

Materiał i metody. Materiałem badawczym było nagranie 705 zawodów. Zanalizowano 685 punktowanych rzutów oraz techniki chwytania poprzedzające punktowane rzuty. Test chi-kwadrat został użyty do zweryfikowania związku między zmiennymi niezależnymi (chwyt oburącz, zmiana chwytu, cel

chwytu i rzut rotacyjny) a zmienną zależną (wynik uzyskany dzięki technice rzutu). Najbardziej skuteczny wzorzec został wyjaśniony poprzez stworzenie schematu obejmującego 36 wzorców taktycznych.

Wyniki. Stwierdzono, że najbardziej skutecznym wzorcem taktycznym w wielu kategoriach wagowych jest użycie chwytu oburącz bez użycia chwytu krzyżowego i zmiany chwytu, chwytanie za kołnierz i rękawy, a następnie wykonanie rzutu rotacyjnego. Dodatkowo potwierdzono związek między kolejnymi krokami taktycznymi w atakach oburęcznych. Okazało się, że rzut rotacyjny przy chwycie za kołnierz i rękaw(y) oraz rzut bez rotacji przy chwycie w okolicy pleców przynajmniej jedną ręką był skuteczny.

Wnioski. Autorzy uzyskali dane z różnych perspektyw. Poprzez połączenie wielu punktów danych z różnych perspektyw, trenerzy mogą udzielać zawodnikom bardziej skoncentrowanych porad taktycznych w każdej kategorii wagowej.