

COACHING & KINESIOLOGY

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Match duration during high-level judo competitions: Golden score or not?

Submission: 23.04.2020; acceptance: 9.09.2020

Key words: *judo*, match duration, golden score, sex, weight categories

Abstract

Background. Recent rule changes have led to alterations in the technical and tactical components of judo matches and athletes' physical capacities. There have also been many changes regarding total match durations during high-level judo matches.

Problem and aim. There is no study under the current refereeing rules that investigates both total match duration, and the factors leading to the competition continuing after the golden score. This study investigated the factors that affected total match duration during high-level judo matches.

Methods. The data were obtained from a total of 5111 official judo matches during the latest two world championships (2018–2019) and eight grand prix tournaments (2019). The Mann-Whitney-U test was used to determine the difference in total match duration between men and women, while differences among the weight categories were investigated using the Kruskal-Wallis test. The difference in the percentage of matches with or without a golden score according to weight categories was analysed by the Chi-square test. The factors leading to a match ending in a golden score were investigated using logistic binary regression analysis.

Results. The total match duration decreased as the weight categories in both men and women increased. Likewise, increasing the weight category led to an increase in the percentage of matches that ended before the official time and a decrease in normal match duration and matches that ended in the golden score. Sex did not affect this distribution. The possibility of a golden score in other weight categories was 2-3 times higher compared to heavyweight classes (OR=1.77-2.84, p=0.00). The lack of ippon score in the matches significantly increased the possibility of a golden score (OR=1.53, p=0.00). The possibility of a third waza-ari (2 vs 1) during a golden score was 3 times higher compared to the matches that ended before the official match duration (OR=3.12, p=0.00). Moreover, a waza-ari increased the possibility of matches ending before or at normal match duration by 1.3 times while two waza-ari increased it by 5.54 times. The possibility of a golden score in the matches with a shido was higher compared to those without a shido. This possibility increased more as long as the number of penalties increased.

Conclusions. The total duration of the matches was affected by weight categories, the number of scores, and penalties. In particular, receiving a shido was found to be an important factor in terms of a longer match duration. The increase in weight categories led to a shorter match duration. The investigation of the match duration and the factors affecting it within the current refereeing rules can contribute to coaches and athletes developing training plans and match tactics.

Introduction

The judo refereeing rules have been frequently changed by the International Judo Federation (IJF) [Ceylan, Balci 2017; Samuel *et al.* 2020; Sato 2013]. These changes have led to alterations in technical and tactical components of judo matches as well as athletes' physical capacities [Sterkowicz-Przybycien, Fukuda 2016]. Due to the changes related to how a match ends and normal match duration, many changes have occurred regarding total match durations during high-level judo matches. At the very beginning, judo matches lasted for 20 minutes, and extra time could be given when necessary, according to Kodokan refereeing rules. Then, the match duration was decided by IJF for the world championships and Olympic Games [Ohlenkamp 2019]. Referees decided the winner with flags (*hantei*) in case of a draw at the end of the match between the first world championship in the 1956 and 2001 world championship. Then, a golden score was applied for objectivity [Suganami *et al.* 2005]. The match duration was limited to 5 minutes for both men and women, and the 5-minute golden score was given in case of a draw at the end of the determined time, and when no score was achieved by either of the athletes, the match ended with *hantei*. Later, the duration of the golden score was limited to 3 minutes [Ohlenkamp 2019]. In 2013, the limit for the golden score was omitted, and the match ended with a first score or penalty [Ohlenkamp 2019]. In 2018, the matches were stated to end with an obvious score of superiority during the golden score, which means that penalties are not equal to the scores except *hansoku-make* [IJF 2019]. Moreover, the match duration was shortened to 4 minutes firstly for women athletes. Then it was also limited to 4 minutes for men athletes [IJF 2017]. The changes related to how a match ends as well as the normal match duration have indirectly affected the total duration of the matches. At present, because there is no time limit for the golden score and matches can end before the officially determined time, there is no current information about the total match duration. Moreover, it was thought that many factors affect the total match duration and lead the matches to continue the golden score.

When previous studies related to the match duration were investigated, it has been reported that sex, weight category, and different rule changes have affected the match duration [Ceylan, Balci 2021; Calmet *et al.* 2017a; 2017b; Sterkowicz-Przybycien *et al.* 2017]. A study, which compared the matches from the 2012 and 2016 Olympic Games, reported that the match duration changed according to weight categories, but sex did not alone affect the match duration. Still, the matches lasted shorter in the 2016 Olympics for both sexes compared to the 2012 Olympics due to the rule changes [Calmet *et al.* 2017a]. When the matches during the 2015 and 2017 world championships were compared, it was noted that weight categories and rule changes did not significantly

affect the match durations and the match durations in women athletes were higher than men athletes [Calmet *et al.* 2017b]. Previous research claimed that many of the matches during high-level judo competitions ended before the official time and the percentage of the matches with the golden score was too low (approximately 2-7%) [Balafoutas *et al.* 2012; Segedi *et al.* 2014; Witkowski *et al.* 2012]. However, a more recent study by Calmet *et al.* [2017b] noted that the percentage of the matches with the golden score increased due to the rule changes.

Each rule change has directly or indirectly affected the match duration, the possibility of a golden score as well as technical-tactical components of a judo match. This situation affected the adaptation of coaches and athletes to competitions [Samuel *et al.* 2020]. Understanding of the match duration variation across sexes and weight categories may help coaches and strength and conditioning professionals to prepare their athletes according to the specific demands of a judo match and help them improve themselves to put new tactics according to factors that affect the match duration. Coaches have an important role in athletes' performance, and they can put the knowledge they have access into practice to maximize the performance and the possibility of winning a match.

No study investigates the total match duration and the factors leading the competition to continue the golden score during the matches that have been organised under the current refereeing rules. Therefore, this study aimed to investigate the effect of sex and weight categories on the total match duration and the relationship between the matches with golden score and the number of scores and penalties. The study had two hypotheses: First, the total match duration and the percentage of the matches that ended in the golden score during the high-level judo competitions were significantly affected by the sex and weight category. Second, it was assumed that the results would lead to the end of matches more in a golden score than in the case of penalties.

Method

The data were not generated from experimentation; they were obtained in a secondary form from the official websites of the IJF, and the personal identifications of the athletes were not given. Therefore, there was no ethical issue in interpreting the data [Calmet *et al.* 2017a]. Matches during the 2018 and 2019 World Championships and 8 Grand Prix in 2019 were included in the study. The matches with *fusen* and *kiken geschi* were excluded from the study and a total of 5111 official matches, 2191 of which were in women and 2920 of which were in men, were included in the analysis. All the matches were performed according to the same refereeing rules by the IJF. The official match duration was 4 min for both male and female athletes. The matches came to an end

before the official match duration because of scoring *ippon*, *waza-ari-awasete-ippon*, or being disqualified with *hansoku-make*. When the official duration ended, if there was a score superiority (*waza-ari*), the match came to an end. In case of a draw at the end of the official match duration, the match continued to the golden score during which the scores and penalties from the official match duration were still valid. There is no time limit in the golden score, and the match comes to an end with a score or *hansoku-make*. In this study, analysis was carried out with the number of scores and penalties during a match instead of how a match ended (*waza-ari-awasete-ippon* or *hansoku-make*). Therefore, at the end of combat, the scoreboard can display the following advantages or penalties as examples: one *ippon* (1 vs 0), three *waza-ari* (2 vs 1), five *shidos* (3 vs 2).

The weight categories were classified as follows: extra-lightweight (-48kg, -60kg), half-lightweight (-52kg, -66kg), lightweight (-57kg, -73kg), half-middleweight (-63kg, -81kg), middleweight (-70kg, -90kg), half-heavyweight (-78kg, -100kg) and heavyweight (+78kg, +100kg). When the scores and penalties were evaluated, the total data of the winner and defeated athletes were used together.

Statistical analysis

Frequency and percentage were used as descriptive statistics. Mean values, standard deviations, and 95% confidence intervals of the variables were given. The normality of the

data was verified with the Shapiro-Wilk test. The difference in total match duration between men and women athletes was investigated using the Mann-Whitney-U test, while the Kruskal-Wallis test was used to determine the differences among weight categories. The difference in the matches that ended at the end or before the normal match duration and during golden score according to sex (2x3) and weight categories (3x7) were analysed with the Chi-square test, and the effect size was determined using Cramer's-V. The degrees of factors that affected the duration of the matches were determined with binary logistic regression analysis. The ratios related to each possibility factor (odds ratios; OR), their 95% confidence intervals and, Wald test statistics were calculated. Statistical analyses were carried out using Statistical Package for the Social Sciences (SPSS) 22.0. Significance was set at $p < 0.05$.

Results

The mean values, standard deviation, and 95% confidence intervals of the judo match durations according to sex and weight categories are presented in Table 1.

No difference was found in the match duration between men and women athletes for each weight category ($p > 0.05$). According to Kruskal-Wallis test results, the duration of all matches significantly differed according to weight categories ($\chi^2_{(6, n=5111)} = 38.60, p = 0.00$). When the weight category increased, the match duration significantly decreased in both men ($\chi^2_{(6, n=2920)} = 16.32, p = .01$) and women athletes ($\chi^2_{(6, n=2191)} = 23.45, p = .00$).

Table 1. distribution of the match duration according to sex and weight categories

WC	Men				Women				Total			
	Mean	SD	%95 CI		Mean	SD	%95 CI		Mean	SD	%95 CI	
			Lowest	Highest			Lowest	Highest			Lowest	Highest
1	196.3	± 105.9	185.7	207.0	192.3	± 103.3	180.6	204.1	194.6	± 104.7	186.7	202.4
2	204.2	± 110.5	194.0	214.4	197.7	± 113.2	185.5	209.8	201.4	± 111.6	193.6	209.2
3	197.0	± 110.2	187.1	206.8	192.6	± 115.6	180.6	204.6	195.1	± 112.5	187.5	202.7
4	192.4	± 100.5	183.4	201.4	190.5	± 108.9	178.8	202.3	191.6	± 103.9	184.5	198.8
5	188.8	± 98.0	179.7	197.8	182.7	± 104.0	171.5	193.9	186.2	± 100.6	179.1	193.3
6	185.7	± 97.1	175.9	195.5	173.9	± 108.5	161.2	186.6	180.6	± 102.2	172.8	188.5
7	174.8	± 89.4	164.5	185.1	162.9	± 91.4	151.5	174.3	169.3	± 90.4	161.7	176.9
Total	192.3	± 102.9	188.6	196.0	185.7	± 107.7	181.2	190.2	189.5	± 105.0	186.6	192.4

WC=Weight category; SD=Standard deviation; %95 CI= %95 lowest and highest values of confidence interval, 1=extra-lightweight, 2=half-lightweight, 3=lightweight, 4=half-middleweight, 5=middleweight, 6=half-heavyweight, 7=heavyweight

Table 2. The frequency and percentage of the matches durations

	Normal Match Duration (4 min)		Golden Score (4min>)	
	Before <4 min	In 4 min		
Women	1452 (%66.3)	320 (%14.6)	419 (%19.1)	2191 (%100)
Men	1871 (%64.1)	429 (%14.7)	620 (%21.2)	2920 (%100)
Total	3323 (%65.0)	749 (%14.7)	1039 (%20.3)	5111 (%100)

Table 3. Frequency and percentage of the match durations according to weight category

Weight category	Normal March Duration (4 min)			Total
	Before <4 min	In 4 min	Golden Skor (4min>)	
Extra-lightweight	427 (%62.5)	118 (%17.3)	138 (%20.2)	683 (%100)
Half-lightweight	458 (%58.2)	129 (%16.4)	200 (%25.4)	787 (%100)
Lightweight	523 (%62.1)	137 (%16.3)	182 (%21.6)	842 (%100)
Half-middleweight	526 (%64.6)	126 (%15.5)	162 (%19.9)	814 (%100)
Middleweight	512 (%65.5)	120 (%15.4)	149 (%19.1)	781 (%100)
Half-heavyweight	456 (%69.0)	74 (%11.2)	131 (%19.8)	661 (%100)
Heavyweight	421 (%77.5)	45 (%8.3)	77 (%14.2)	543 (%100)
Total	3323 (%65)	749 (%14.7)	1039 (%20.3)	5111 (%100)

Table 4. The odds ratios (OR), 95% confidence intervals, regression coefficients (β) and standard errors (SE) of the factors that affected match duration

Factors	Normal match duration and before/Golden score						
	β	SE β	P	OR	%95 Confidence interval		
					Lowest	Highest	
Sex	0.05	0.08	0.54	1.05	0.90	1.23	
Heavyweight			0.00				
Extra-lightweight	0.62	0.17	0.00	1.87	1.33	2.61	
Half-lightweight	1.05	0.17	0.00	2.84	2.06	3.93	
Lightweight	0.89	0.17	0.00	2.43	1.76	3.36	
Half-middleweight	0.66	0.17	0.00	1.94	1.40	2.69	
Middleweight	0.57	0.17	0.00	1.77	1.27	2.46	
Half-heavyweight	0.70	0.17	0.00	2.02	1.44	2.84	
İppon (yes)	0.42	0.11	0.00	1.53	1.24	1.89	
Waza-ari (no)			0.00				
One waza-ari	-0.26	0.10	0.01	0.77	0.63	0.94	
Two waza-ari	-1.54	0.19	0.00	0.21	0.15	0.31	
Three waza-ari*	1.14	0.24	0.00	3.12	1.96	4.98	
Shido (no)			0.00				
One shido	0.61	0.18	0.00	1.83	1.28	2.62	
Two shido	1.55	0.16	0.00	4.72	3.43	6.48	
Three shido	2.19	0.16	0.00	8.91	6.47	12.27	
Four shido	2.64	0.17	0.00	14.04	9.98	19.76	
Five shido**	3.11	0.22	0.00	22.46	14.56	34.67	
Constant	-3.73	0.20	0.00	0.02			

The significance level was important for the model (Hosmer and Lemeshow test; $\chi^2=31.07$, $p=0.00$). The accuracy was %80.6. $R^2=0.18$ (Cox ve Snell). $R^2=0.28$ (Nagelkerke). * Waza-ari-awasete-ippou after the mutual waza-ari for competitors. ** Maximum shido number given during each match

According to Chi-square independence test results, the number of the matches that ended before the official time, at the official time and during the golden score was the same in the men and women athletes ($\chi^2_{(2, n=5111)}=3.67$, $p=0.16$; Cramer's $V=0.03$ [small effect]), (Table 2). The percentage of the matches that ended before the official time, at the official time and during the golden score were different among the weight categories ($\chi^2_{(12, n=5111)}=71.1$, $p=0.00$; Cramer's $V=0.08$ [Small effect]). When the weight category increased, the percentage of the matches that ended before the official time increased, but the number of the matches that ended at the official time and during the golden score decreased (Table 3).

Table 4 presents the binary logistic regression results related to the effect degrees of the sex, weight categories, scores, and penalty number factors on the golden score. In this model, the weight categories, the total number of *waza-ari*, and the total number of penalties were calculated as ordinal variables, whereas the sex and whether there is a *shido* were calculated as categorical variables. The sex was found not to have any effect if a match ended in the golden score (OR=1.5, $p=0.54$). The weight category was a significant factor if a match ended in the golden score ($p=0.00$): the possibility of golden score was two or three times higher in other weight categories compared to heavyweight athletes (OR=1.77-2.84, $p=0.00$). The lack of

ippon during the match significantly increased the possibility of the golden score (OR=1.53, $p=0.00$).

The possibility of the matches to end at the 4th minute or before was increased if: one obtained a single *waza-ari* (1.3 times, OR=0.77, $p=0.01$), one obtained two *waza-ari* (2 vs 0) (4.54 times, OR=0.22, $p=0.00$). At the end of the 4th minute, the score tie (1 *waza-ari* vs 1 *waza-ari*) leads to a third *waza-ari* during the “golden score” 3 times higher (OR=3.12, $p=0.00$) than the scoreless tie.

Penalties significantly affected the possibility of the golden score ($p=0.00$). When the number of the penalty increased, the possibility of the golden score increased in the matches with penalties compared to those without a penalty. The possibility increased by almost two times with a single *shido* (OR=1.83, $p=0.00$), five times with two *shidos* (OR=4.72, $p=0.00$), nine times with third *shido* (OR=8.91, $p=0.00$), 14 times with fourth *shido* (OR=14.04, $p=0.00$) and 22 times with fifth *shido* (OR=22.46, $p=0.00$).

Discussion

This study investigated the factors that affected the total match duration and if a match ended in the golden score during the high-level judo competitions. The most notable finding of the study was that each *shido* significantly increased the possibility of the golden score. Table 4 presents the binary logistic regression results related to the effect degrees of the sex, weight categories, scores, and penalty number factors on the golden score. In this model, the weight categories, the total number of *waza-ari*, and the total number of penalties were calculated as ordinal variables, whereas the sex and whether there is a *shido* were calculated as categorical variables. The sex was found not to have any effect if a match ended in the golden score (OR=1.5, $p=0.54$). The weight category significantly affected the match to end in the golden score ($p=0.00$): the possibility of golden score was two or three times higher in other weight categories compared to heavyweight athletes (OR=1.77-2.84, $p=0.00$). The lack of *ippon* during the match significantly increased the possibility of the golden score (OR=1.53, $p=0.00$).

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The match duration and the percentage of the matches with the golden score differed according to the weight categories. The results of this study showed that the heavier the weight categories were, the shorter the match durations were. The results of the logistic regression supported this finding as the possibility of the golden score in the other categories was two times higher than heavyweight athletes. Similar results were reported in a study that investigated the 2012 and 2016 Olympic Games [Calmet *et al.* 2017a]. Nevertheless, it was reported the weight category did not affect the match duration during world championships [Calmet *et al.* 2017b]. The difference among the abovementioned findings can be explained by the frequent rule changes.

Conclusions

The results of this study showed that the match duration and the possibility of the golden score were higher in light and middleweight categories. Moreover, it can be concluded that the number of penalties increased the possibility of the golden score. Each rule change has affected the technical and tactical components of a judo match as well as the adaptation of coaches and athletes. Therefore, it can be suggested for coaches, strength and conditioning professionals to prepare their athletes according to the specific demands of a judo match according to their sex and weight categories. While preparing the training programs, they should consider that lightweight matches last longer and so they should improve endurance performance as well as other components of judo performance in the lightweight athletes while improving agility, speed and explosive power of the heavyweight athletes to present more decisive actions at the beginning of the match. Also, athletes should develop technical and tactical superiority against their opponents to avoid penalties due to inactivity.

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Czas trwania walki podczas zawodów judo na najwyższym stopniu: Złoty wynik czy nie?

Słowa kluczowe: judo, czas trwania meczu, złoty wynik, płeć, kategorie wagowe

Streszczenie

Tło. Ostatnie zmiany w przepisach doprowadziły do zmian w technicznych i taktycznych elementach walk judo oraz w możliwościach fizycznych zawodników, a także do wielu zmian w całkowitym czasie trwania walki podczas rozgrywek judo na wysokim stopniu.

Problem i cel. Autorzy pracy nie znaleźli badań, które analizowałyby całkowity czas trwania meczu i czynniki prowadzące do kontynuowania rywalizacji do złotego wyniku przy obecnych przepisach sędziowskich. W niniejszej pracy badano więc czynniki wpływające na całkowity czas trwania walki podczas wysokiej rangi zawodów judo.

Metody. Dane uzyskano z łącznie 5111 oficjalnych meczów judo podczas ostatnich dwóch mistrzostw świata (2018-2019) i ośmiu turniejów grand prix (2019). Test Manna-Whitney-U został użyty do określenia różnicy w całkowitym czasie trwania walki między mężczyznami i kobietami, podczas gdy różnice między kategoriami wagowymi zostały zbadane za pomocą testu Kruskala-Wallisa. Różnice w odsetku walk z lub bez złotego wyniku w zależności od kategorii wagowej analizowano testem Chi-kwadrat. Czynniki prowadzące do zakończenia walki złotym wynikiem badano za pomocą logistycznej analizy regresji binarnej.

Wyniki. Całkowity czas trwania walki skracał się wraz ze wzrostem kategorii wagowych zarówno u mężczyzn, jak i u kobiet. Podobnie, wzrost kategorii wagowej prowadził do wzrostu odsetków meczów zakończonych przed oficjalnym czasem oraz do spadku normalnego czasu trwania walki i walk zakończonych złotym wynikiem. Płeć nie miała wpływu na ten rozkład. Możliwość złotego wyniku w innych kategoriach wagowych była dwa-trzy razy wyższa w porównaniu do wagi ciężkiej (OR=1,77-2,84, p=0,00). Brak ippon score w walkach znacząco zwiększał możliwość uzyskania złotego wyniku (OR=1.53, p=0.00). Możliwość wystąpienia trzeciego waza-ari (2 vs 1) podczas złotego wyniku była 3 razy większa w porównaniu do walk, które zakończyły się przed oficjalnym czasem trwania walki (OR=3.12, p=0.00). Ponadto, jeden waza-ari zwiększał prawdopodobieństwo zakończenia walki przed normalnym czasem jej trwania 1,3 razy, podczas gdy dwa waza-ari zwiększało je 5,54 razy. Możliwość zdobycia złotego wyniku w walkach shido była wyższa w porównaniu do tych bez shido. Prawdopodobieństwo to wzrastało wraz ze wzrostem nałożonych kar.

Wnioski. Na całkowity czas trwania walk miały wpływ kategorie wagowe, liczba zdobytych punktów i kar. Szczególnie otrzymanie shido okazało się być ważnym czynnikiem wpływającym na dłuższy czas trwania meczu. Wzrost kategorii wagowych prowadził do skrócenia czasu trwania walki. Badanie czasu trwania spotkania i czynników wpływających na niego w obecnych przepisach sędziowskich może pomóc trenerom i zawodnikom w planowaniu treningu i taktyki walki.