OLYMPIC AND PARALYMPIC GAMES RIO 2016: A TECHNICAL-TACTICAL ANALYSIS OF JUDO MATCHES

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Abstract:

The purpose of this study was to compare athletes' scores, penalties and efficiency between the Olympic and Paralympic Games Rio 2016, and identify which variable determined the winner of the matches. A total of 608 matches in the Olympic and Paralympic Games were analysed. Total relative scores (*ippon, waza ari* and *yuko*), penalties (*shido* per match) and efficiency were identified in the following categories: male and female, Olympic and Paralympic Games, and medallists and non-medallists. The main results showed that *waza ari* was higher in the Olympic Games (p=.05) than in the Paralympic Games (male team); *ippon* was higher in the Paralympic Games (p=.05) and *shido* was higher in the Olympic Games (p=.05) (female team). The male Olympic medallists were more efficient (p=.01), while the female Paralympic medallists were less penalised (p=.01). *Ippon* was the key variable that determined winning in both the Olympic and Paralympic matches (p<.001). We concluded that the male Olympic judo athletes showed greater efficiency and scores than Paralympians, while the female team presented more scores and fewer penalties. *Ippon* was the key point that determined victory in most of the matches.

Key words: *score analysis, competitive performance, Olympic sport, Paralympic sport*

Introduction

Judo is an acyclic and high-intensity intermittent Olympic and Paralympic sport, which requires complex technical and tactical skills and puts high physiological and neuromuscular demands (Franchini, Takyto & Bertuzzi, 2005; Franchini, Matsushigue, Del Vecchio & Artioli 2011; Franchini, Artioli & Brito 2013; Loturco, et al., 2016). Judo was included, as a competitive sport, at the Paralympic Games in Seoul 1988 (men) and Athens 2004 (women). The sport is open to athletes with visual impairments in several weight categories, similar to the Olympic Games (International Paralympic Committee – IPC, 2017). In high-level judo competitions, such as in the Olympic and Paralympic Games, the ratio effort: pause during a combat is high. In the Olympic judo matches, the ratio effort: pause is close to 2:1 or 3:1 (Miarka, Julio, Del Vecchio, Calmet & Franchini, 2010; Miarka, et al., 2012; 2014), while in the Paralympic matches shorter work sequences (13 seconds) and longer breaks (20 seconds) have been observed (effort: pause ratio of 1:2) (Gutiérrez-Santiago, Prieto, Camerino & Anguera, 2011; Gutiérrez-Santiago, Cancela, Zubiaur & Ayán, 2012). This difference is possibly because in the Paralympic combat the athlete initiates the match with his/her hands positioned in the *judogi* of the opponent (*kumi-kata)* and this procedure is repeated every time the combat has been interrupted (Gutiérrez-Santiago, et al., 2011).

During the match competition, judo athletes are constantly searching to throw or finalize the opponents (Franchini, et al 2013a; Miarka, et al., 2016b; Sterkowicz, Sacripanti & Sterkowicz-Przybycien, 2013). Different scores can be attributed regarding the type of the opponent's throwing to the ground, immobilization time or finalization. According to the current rules, from 2016, the scores are comprised of *ippon* (maximum score – determining the end of the match), *waza ari* (1/2 *ippon*) and *yuko* (1/4 *ippon*) (International Judo Federation – IJF, 2016). Furthermore, the referee can attribute penalties (named shido) to the athletes. The *shido* does not determine the score but, in the absence of scores, it decides the winner. Four *shido* determine the *hansokumake* (disqualification). A previous study (Escobar-Molina, Courel, Franchini, Femia, & Stankovic, 2014) noted that, in 20.7% of matches in the tournaments valid for the World Ranking List in 2013, the outcome was decided by penalties,

especially in heavyweight categories. This information is still missing for blind judo athletes.

The analysis of judo matches during the competitions can be performed using different parameters, such as temporal structure (time actions), technical variety (types of techniques and their variations), scores, penalties, and the combination of different elements, such as efficiency indexes (Miarka, et al., 2010; Adam, Smaruj, & Pujszo, 2012). The latter refers to the types of scores (*ippon*, *waza ari* or *yuko*) awarded during the combats and the total number of combats. This index was proposed by Adam, Smaruj and Tyszkowski (2011) and was used to describe the competitive performance of the Russian team during the Olympic Games in 2012 (Adam, Tabakov, Blach & Smaruj, 2013). Other studies have already used the efficiency index to evaluate the performance of judo athletes in a single competition (Adam, et al., 2011;2012; 2013; Ito, et al, 2014) and to compare the impact of new rules on performance in official competitions (Miyake, Sato & Yokoyama, 2016). So far, no studies have investigated efficiency indexes in the Paralympic matches.

Simple analyses of scores, penalties and efficiency indexes across matches can provide important information about technical and tactical elements and performance of judo athletes during a season. Furthermore, the coach can better understand training effects on each athlete and his/her opponents (Adam, et al., 2011; 2013). However, the greatest question asked by coaches is: what does determine the victory and the medal winning, mainly in a high-level competition? An interesting study conducted by Franchini and Takito (2014) found that the volume of training (hours per week, sessions per day, time and frequency of judo-specific and general exercises), as well as the psychological perception of training (effort, pleasure, and concentration) were similar between the Brazilian medal winners compared to the non-medal winners during the preparation for the Olympic Games. Thus, it seems that technical-tactical training or long-term athletic development are responsible for performance in a high-level competition.

Despite this preliminary evidence, studies remain scarce of the technical-tactical determinants of success in judo matches regarding Olympic athletes compared to Paralympians. Therefore, it is critical to identify which technical-tactical variables determine the medallist: the number and quality of scores, penalties or efficiency. To the best of our knowledge, no other studies have investigated these variables. It remains to be seen whether scores, penalties and efficiency differentiate between the Olympic and Paralympic judo athletes. Thus, the first aim of this study was to compare the scores, penalties and efficiency indexes in male and female judo athletes between the Olympic and Paralympic Games Rio 2016 (general and medallists); the second aim was to identify which variable (score or penalties) determined the outcome (winner) of the matches in both the Olympic and Paralympic Games. We hypothesized that: i) the Olympic medallist athletes in both male and female teams will have better scores and efficiency indexes, as well as a higher number of penalties, compared to the Paralympic medallist athletes, due to technical-tactical differences during competition (e.g., work rate and breaks during the matches) (Gutiérrez-Santiago, et al., 2011, 2012); ii) scores (*ippon*, *waza ari/yuko*) will determine the outcome of the matches instead of the penalties in the Olympic and Paralympic Games.

Methods

Data sample

The official results, published on the website (www.judobase.org), which is linked to the International Judo Federation website (IJF, 2016), were retrieved on October 15th, 2016 for a technical-tactical analysis of the matches performed in the Olympic and Paralympic Games Rio 2016. In the Paralympic Games, a total of 129 athletes participated in the competition, comprising 82 men and 47 women. Twenty four athletes were B1 class (very low visual acuity and/or no light perception); 58 were B2 class (higher visual acuity than athletes competing in the B1 class and a visual field of less than 5 degrees radius); and 47 athletes were B3 (highest visual acuity and a visual field of less than 20 degrees radius) (IPC, 2017). In the Olympic Games, a total of 390 athletes participated in the competition, 237 men and 153 women. We analysed Olympic and Paralympic athletes of the seven weight categories.

A total of 608 matches were analysed of the male and female judo teams participating in the Olympic and Paralympic Games. Total relative scores (*ippon*, *waza ari* and *yuko*), penalties (*shido* per match) and efficiency were analysed in the following categories: male and female teams, Olympic and Paralympic Games, medallists and non-medallists, and the type of medal won – gold, silver, or bronze. The efficiency was calculated by the following equation (Adam, et al., 2011):

$$\text{Efficiency} = \frac{\begin{array}{c}(\text{number of ippon} \times 10) + \\ (\text{number of waza ari} \times 7) + (\text{number of yuko} \times 5)\end{array}}{\text{Total number of matches}}$$

Equation (1)

According to Morley and Thomas (2005), there are no ethical issues in analysing or interpreting data from open access websites, since they were obtained in secondary form and were not generated by an experimentation. Furthermore, an athlete's personal identification was not used and only final

results were considered. Similar analyses were used in previous studies (Franchini, Takito & Calmet, 2013b; Miyake, et al., 2016; Miarka, et al., 2014; Escobar-Molina, et al., 2014).

Statistical analysis

The values of the scores (*yuko*, *waza ari* and *ippon*) and the penalties were normalised by the total number of matches in each category (Olympic and Paralympic Games), and according to the gender (male and female teams). After, the values were converted in percentages and presented as simple frequency. The Kolomogorov-Smirnov test showed that the data presented normal distribution and the Levene's test showed equality of variance. Thus, a *t*-test was used to compare the scores, penalties and the efficiency indexes between the Olympic and Paralympic athletes, as well as between medallist and non-medallists of both sports. One-way ANOVA with Bonferroni *post-hoc* was used to compare different medallists (gold, silver and bronze) in both the Olympic and Paralympic Games, and to compare the variables *ippon*, *waza ari* and *yuko*, and *shido* (penalties) in each sport. The significance level was set at p<.05 and the analysis was conducted by SPSS, version 17.0.

Results

Table 1 presents the frequency of scores, penalties (*shido*) and efficiency of all male and female judo athletes in the Olympic and Paralympic Games. Regarding the male team, the score *waza ari* was higher in the Olympic Games (p=.047) than in the Paralympics. In the female team, the score *ippon* was higher in the Paralympic Games (p=.05) and the *shido* per match was higher in the Olympic Games (p=.05).

Table 2 shows the frequency of scores, penalties (*shido*) and efficiency of judo male and female Olympian and Paralympian medallists. In the male medallist team, the efficiency was higher in the Olympic Games (p=.008) than in the Paralympics, while in the female medallist team, the *shido* per match was higher in the Olympics (p=.01) than in the Paralympics.

Table 3 shows the comparison of scores, penalties (*shido*) and efficiency of judo male Olympian and Paralympian medallists. No significant differences were found among the gold, silver and bronze medallists in either Game, indicating a high technical and tactical level of the finalists.

Table 4 shows the comparison of scores, penalties (*shido*) and efficiency of judo female Olympian and Paralympian medallists. No significant differences were found among the gold, silver and bronze medallists in the Olympic Games. In the Paralympic Games, significant differences were found in the variables *ippon* (F=7.21, p=.004), which was higher in the gold medallists than in the silver and bronze ones, as well in efficiency (F=3.09, p=.05), which was higher in the gold medallists

Table 1. Frequency of scores, penalties (shido) and efficiency of male and female judo athletes in the Olympic and Paralympic Games' tournaments

	Male		Female	
	Olympic Games (n = 258)	Paralympic Games (n = 112)	Olympic Games (n = 174)	Paralympic Games (n = 64)
Ippon (%)	60.11±8.4	54.64±14.54	50.23±11.77	63.81±16.15*
Waza ari (%)	24.82±7.96*	16.04±9.98	19.31±10.45	17.68±8.89
Yuko (%)	38.21±13.01	47.23±21.95	47.27±14.27	41.24±16.26
Shido/match (n)	1.8±0.2	1.4±0.6	1.6±0.3*	0.9±0.5
Efficiency (%)	8.0±1.5	8.1±2.4	8.6±1.6	8.6±1.2

Note. * p < 0.05; n = number of matches.

Table 2. Frequency of scores, penalties (shido) and efficiency of judo male and female Olympian and Paralympian medallists

	Male medallists		Female medallists	
	Olympic Games (n = 139)	Paralympic Games (n = 85)	Olympic Games (n = 28)	Paralympic Games (n = 24)
Ippon (%)	49.5±20.5	54.8±31.7	41.8±22.9	49.3±23.8
Waza ari (%)	19.6±19.7	19.0±21.1	15.0±23.9	11.10±16.0
Yuko (%)	20.7±22.1	30.6±30.0	30.4±26.6	24.9±26.5
Shido/match (n)	0.8±0.4	0.7±0.6	0.7±0.5*	0.4±0.5
Efficiency (%)	29.4±13.3*	21.7±9.9	6.2±2.9	5.7±3.3

Note. * p < 0.05; n = number of matches.

Table 3. Frequency of scores, penalties (shido) and efficiency of judo male Olympian and Paralympian medallists (gold, silver and bronze medals)

	Olympic Games			Paralympic Games		
	Gold (n = 7)	Silver (n = 7)	Bronze (n = 14)	Gold (n = 7)	Silver (n = 7)	Bronze (n = 14)
Ippon (%)	52.1±27.1	42.9±18.0	51.4±18.7	71.4±30.0	47.6±17.9	50.0±36.4
Waza ari (%)	30.0±20.8	20.0±23.1	14.3±16.5	19.0±26.3	9.5±16.2	23.8±20.4
Yuko (%)	17.1±24.3	20.0±16.0	22.9±24.6	27.4±22.9	19.0±26.2	38.1±34.2
Shido/match (n)	0.7±0.4	0.7±0.4	0.8±0.4	0.8±0.5	1.0±0.9	0.5±0.5
Efficiency (%)	31.4±12.9	27.7±8.8	29.3±15.8	24.0±6.6	14.9±6.6	23.9±11.4

Table 4. Frequency of scores, penalties (shido) and efficiency of judo female Olympian and Paralympian medallists (gold, silver and bronze medals)

	Olympic Games			Paralympic Games		
	Gold (n = 7)	Silver (n = 7)	Bronze (n =14)	Gold (n = 6)	Silver (n = 6)	Bronze (n = 12)
Ippon (%)	47.6±29.8	35.7±24.4	41.8±19.2	75.0±20.4*	38.9±13.6	41.7±20.7
Waza ari (%)	27.6±36.9	3.8±9.4	14.3±18.9	16.7±18.2	5.6±13.6	20.7±23.8
Yuko (%)	27.1±29.4	35.7±34.9	29.3±21.9	33.4±36.5	16.6±18.2	25.0±25.1
Shido/match (n)	0.7±0.6	0.8±0.4	0.7±0.6	0.3± 0.4	0.7±0.6	0.2±0.4
Efficiency (%)	7.1±3.6	5.6±4.1	6.0±1.9	8.3±4.5#	4.0±2.2	5.4±2.5

Note. n = number of matches. *Significantly different from silver and bronze; #significantly different from silver.

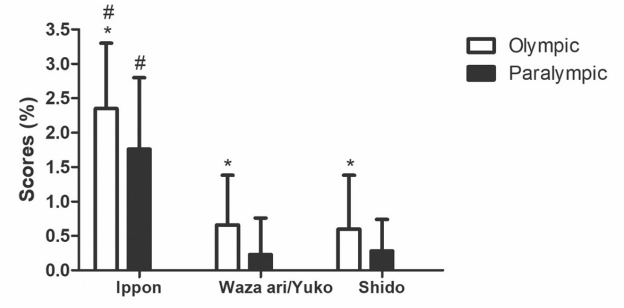

*Figure 1. Frequency of ippon, penalties (shido) and waza ari/yuko of judo male Olympian and Paralympian medallists. *Significant difference between the Olympians and Paralympians; # significant difference between the scores in each sport.*

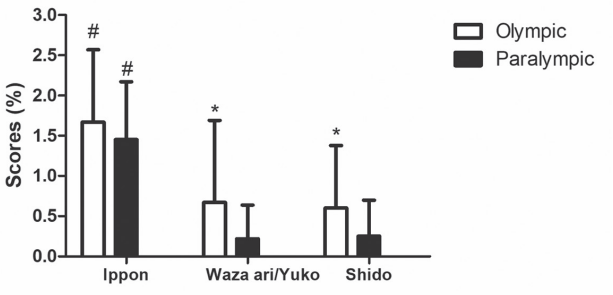

*Figure 2. Frequency of ippon, penalties (shido) and waza ari/yuko of judo female Olympian and Paralympian medallists. *Significant difference between the Olympians and Paralympians; # significant difference between the scores in each sport.*

than the silver medallists. No significant differences were observed regarding each medal between the Olympic and Paralympic Games.

The variables *ippon*, *waza ari/yuko* or penalties determined the outcome of the match in both the Olympic and Paralympic Games. Figure 1 shows the comparisons between the male Olympian and Paralympian medallists. The variables *ippon* (p=.02), *waza ari/yuko* (p=.005) and *shido* (p=.04) were higher in the Olympic compared to the Paralympic athletes. The number of *ippon* was higher than *waza ari/yuko* and *shido* in both the Olympic (F=50.30, p<.001) and Paralympic male athletes (F=17.13, p<.001); however, no differences were found between *waza ari/yuko* and *shido.* This indicates that the score *ippon* was the key variable that determined winning in both the Olympic and Paralympic matches.

Figure 2 shows the comparison among the scores of *ippon*, penalties (*shido*) and *waza ari/yuko* in judo female Olympian and Paralympian medallists. The scores of *waza ari/yuko* (p=.002) and *shido* (p=.004) were higher in the Olympic compared to the Paralympic athletes; however, in the *ippon* no significant difference was found (p=.16). When the scores were compared, the percentage of *ippon* was higher than *waza ari/yuko* and *shido* in the Olympic (F=17.35, p<.001) and Paralympic female athletes (F=45.9, p<.001); however, there were no significant differences between *waza ari/yuko* and *shido.*

Discussion and conclusions

This study had two purposes i) to compare the scores, penalties and efficiency index in male and female judo athletes between the Olympic and Paralympic Games Rio 2016 (general and medallists) and; ii) to identify which variable (score or penalties) determined the outcome (winner) of the matches in both the Olympic and Paralympic Games. We accepted the first hypothesis only in regard with the male team, since we observed a better efficiency index and more penalties in the Olympic than in the Paralympic athletes (general and medallists). Furthermore, the *ippon* was the score that determined the outcome of the match in both the Olympic and Paralympic (male and female) medallists, rather than penalties; thus, we also accepted the second hypothesis.

We observed that, in the male team, the *waza ari* was higher in the Olympic (25%) than in the Paralympic matches (16%) (Table 1). This could be explained by the different strategies used by the Olympic athletes to win the combat, mainly by using the time to their advantage. In the Paralympic matches, however, the strategies to contain the opponent's attacks were possibly different, since the efficiency and *ippon* were the same between the classes. However, in the female team, we found that the *ippon* was higher in the Paralympic female athletes compared to the Olympic ones, indicating that the Paralympic female athletes performed their attacks with higher efficiency. Also, the female Paralympic team was punished with fewer *shido* than the Olympic female team; i.e., the higher the number of *ippon*, fewer the penalties. Another possibility is that the different characteristics of the Paralympic combat, in which the athlete initiates the match with his/her hands positioned in the *judogi* of the opponent (*kumi-kata)*, result in a combat with more attempts to score and less chance of *shido.*

According to the analysis of medallists, the male Olympic athletes were more efficient than the Paralympic. The Olympic athletes produced greater scores in the matches (Table 2). This difference can probably be explained by the observation that the Olympic athletes have shown a longer time-sequence of attacks (Castarlenas, & Planas, 1997; Miarka, et al., 2016b) and a higher technical variation than the Paralympic athletes (Adam, et al., 201; Franchini, Sterkowicz, Meira Jr., Gomes, & Tani, 2008; Gutiérrez-Santiago, et al., 2012; Sterkowicz, & Franchini, 2000). Similarly to the previous finding regarding the all-female team, the Paralympic medallists presented fewer *shidos* per match compared to the Olympic athletes, probably because of different combat features, which were mainly due to the necessity of *kumi-kata* during the match in the Paralympic athletes.

The comparison of actions among three medallists (gold, silver and bronze) in the Olympic and Paralympic modalities showed no significant differences in the scores, efficiency, or penalties of the male team (Table 3). Boguszewski and Boguszewska (2006) analysed the final European Championships and found significant differences in the total number of attacks and total number of defences in the gold medallists when compared to the silver medallists. In the female team, it was shown that the Paralympic gold medallists had a higher frequency of *ippon* and a higher efficiency compared to other medallists. These findings can be attributed to several factors, such as a high technical variety, tactical attitude or even physiological aspects, since the competitive level is very similar among them. Miarka et al. (2016b) found that female winners have higher attack activities compared to losers, but these attack activities did not always result in scores in the Olympic Games. This confirms that the performance levels of the medallists are very similar.

We also identified the variable (*ippon*, *waza ari*/*yuko* or penalties) that determined the outcome of matches in both the Olympic and Paralympic Games. In the male and female medallists, the score *ippon* was the variable that determined winning in both the Olympic and Paralympic matches (Figures 1 and 2). Firstly, this result suggests that the medallists of both Games may have a high physical fitness or a good technical-tactical standard. Franchini and Takito (2014) found that training routines of Olympic medallists and non-medallists were similar, suggesting that the technical and tactical aspects of their performance were more important to the most outstanding medallists than their physical condition. Furthermore, Miarka, Fukuda, Dell Vecchio and Franchini. (2016a) showed that medallists possessed a greater variety of attack and defensive techniques. Another finding of this study is that the scores *waza ari/yuko* and *shido* did not differ between them, indicating that penalties showed the same frequency as the scores (*waza ari/yuko*) in determining the match outcome. Escobar-Molina et al. (2014) found that, on average, 20.7% of matches in the male and female elite team were decided by the *shido* and 2.9% were decided by *hansokumake* (4 *shido*). Therefore, high-level judo athletes seem to win the matches by the scores (*waza ari/yuko*) or penalties.

Additionally, the *ippon*, *waza ari*/*yuko* and *shido* were higher in the Olympic athletes compared to the Paralympic. Therefore, the Olympians obtained higher scores when compared to the Paralympians, supporting the suggestion that the Olympic athletes presented higher technical and tactical variations. However, the Olympic athletes lost more matches to the *shido* than the Paralympians. This can be explained by the temporal difference between the two scenarios; in the Paralympic matches the time of pause represents 54% of the total time of the

combat and the effort time is only 45.1% (Gutiérrez-Santiago, et al., 2012), while in the Olympic matches, the time of pause is close to 31% and the effort time (combat time) is 67% (Miarka, et al., 2016b). Therefore, it has been suggested that the Olympic judokas are more active during the combat with fewer pauses than the Paralympians, possibly resulting in a higher number of scores and penalties.

We concluded that the male Olympic athletes produced a greater number of *waza ari* scores than the Paralympic athletes, whereas the female Paralympians had a greater number of *ippon* than the Olympians. The male Olympic medallists showed higher efficiency than the Paralympians, and the female Olympians received a higher number of penalties than the Paralympians. Additionally, the *ippon* (not penalties) was the score that determined the outcome in most medallists' matches (male and female teams) in both the Olympic and Paralympic Games. This information is relevant due to several judo rule changes over the last decade (the major changes have been put into effect in 2011-2012, 2013-2016 and 2017), which have resulted in a higher importance attributed to scores and penalties during matches (Calmet, Pierantozzi, Sterkowicz, Challis, & Franchini, 2017; Katcipis, Silva Jr., Kons, & Detanico, 2018). Finally, our findings may help understanding the characteristics of judo matches in high-level competitions, as well as identifying different strategies implemented by male and female athletes in the Olympic and Paralympic sports.

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