

Identifying the technical and tactical characteristics of Olympic medallists in karate

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ABSTRACT

This study primarily aimed to conduct an observational analysis of Olympic finalists' performance to determine the patterns and characteristics of karate at the highest level of competition. Due to the need for a complete analytical system, we can use this study to create useful information about the planning process based on winning strategies. The research is based on an analysis of athletes who go to the final of the Tokyo Olympic Games. Thirty fights in the male competition were analysed. Prevalence, percentage frequency, and nonparametric tests were used (Fisher's exact test, the likelihood ratio test, and Pearson's chi-square test) for data analysis. Quantity indicators showed that male karate athletes tend to use upper limb karate techniques (53.70%) more than lower limb (35.65%) and a combination (upper and lower or lower and upper limb 10.65%). The difference in scoring by two tactical models of attack and counterattack was significant, and 69.2% of the points were scored by attacking. Moreover, the results suggest a predominant scoring technique using the Kisami-Tsuki model has the highest number of attacks. Considering these characteristics can provide important indicators for technical and tactical coaches and physical trainers to design special training conditions for their athletes.

Keywords: Olympic Games, Kumite match, Combat sport, Performance analysis.

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INTRODUCTION

A performance analysis can aid in understanding the nature and complexity of any sport (O'Donoghue, 2010). Therefore, the technical, tactical, physical, and psychological requirements of the sport should be known prior to the development of a training program (Solé, 2015). Combat sports are of acyclic nature because of their highly intense actions and movements (Silva et al., 2011), and an optimum training plan improves athletic performance (Costa, 2013). This analysis provides a more in-depth understanding of the competition, enabling coaches and participants to optimize training, targeting, and understanding of key points to execute their strategy (Smith et al., 2020). Karate has been transformed from traditional Japanese martial arts to a modern fighting sport. The sport was contested for the first time at the 2020 Olympics, and the two events to be contested are kata and kumite (Frigout et al., 2017). Karate is a martial art with continuous technical and tactical phases involving attacking, counterattacking by punching and kicking to score points, and defending (Chaabène et al., 2014; Ashker, 2011). The athlete assesses his opponent during the competition by obtaining points and to win by applying an appropriate and precise strategy. Thus, to be a successful Kumite exponent, the athlete must make quick decisions about making proper offensive and defensive strokes in response to the opponent's actions (World Karate Federation, 2019). We flag that karate competition rules have changed over time. For instance, in 2000 the WKF changed the rules to make karate competitions more dynamic and attractive and to increase safety. Major changes were introduced to the scoring system, the range of permissible techniques was revised and the degree of contact to the head was restricted. In 2009, the scoring system was simplified (Lystad et al., 2020). Kumite competition is normally disputed individually; however, there is a possibility of team competition. In individual competition, athletes are divided according to sex, age, and weight category. The maximum playing time is 3 min (World Karate Federation, 2019). Subsequently, scores are assigned when specific actions are performed. Three points for ippon, when leg techniques touch the opponent's head or sweeping and throwing techniques lead to the fall of the opponent or hitting the opponent on the field; 2 points for waza-ari, when kicks hitting the trunk are performed; and 1 point for yuko, when a single arm punch hits the head or body. Overcontact during an attack is not allowed. Moreover, it is recommended that athletes perform kicks and striking techniques in a controlled manner or stop the toss just before contact with the opponent's target area (World Karate Federation, 2019).

This study aimed to perform a descriptive analysis by observation that can help determine the most relevant trends and characteristics, information regarding the technical offensive action performed, fist or leg. The reaction to the opponent's attacks, which reactions were performed more compared to the other reactions to the opponent's attacks, what was the most successful type of attack (punches, kicks, or combined) gain more points, and the most intense time of the match for the male category in the 2020 Tokyo Olympic Games. In addition to analysing the preference of certain techniques, whether the fists or legs are used, and their effectiveness in Kumite match. The findings of this study are particularly relevant for technicians, coaches, and researchers involved in kumite match.

MATERIALS AND METHODS

Methodology and design

This study was conducted to determine the technical and tactical performance of the gold and silver medallists of the 2020 Tokyo Olympic Games using dartfish analysis technology. All matches in male group in three categories (under 67 kg; under 76 kg and over 76 kg) were analysed. To support this study, the Iran Karate Federation has given the official video and authorised the analysis of all final matches.

Data acquisition and performance measures

The case study items included hand techniques, feet techniques, combination techniques, number of attacks, and number of defensive reactions. Additionally, the techniques were characterised according to good form, enough speed, timing, suitable distance, and power control of the hit to the head and face in order to gain points (World Karate Federation, 2019).

Table 1. Observation tool.

Tactics	
Attack	Direct and indirect attack
Counterattack	Direct response after the end of opponent attack
Blocking	Direct and indirect block
Dodge	Dodge opponent attack
Technique	Punching techniques
Upper limb	Kizami-Zuki (punch with forward anterior hand) Gyaku-zuki-jodan and chudan Kizami-gyaku-zuki-jodan Kizami-gyaku-zuki-chudan.
Lower limb	Kicking techniques: Uko-geri (leg kick in lateral direction) Mawashi-geri-jodan (circled exterior leg kick pointed to the head) – Mawashi-geri-chudan (circled exterior leg kick pointed to the body) Ura-mawashi-geri (circled interior leg kick pointed to the head) – Ushiro-geri (direct leg kick from turn in back direction)
Combination	Combination of punching and kicking techniques
Throwing	Grappling technique that involves off-balancing an opponent, and throwing them to the ground
Techniques on head	Techniques movements pointed to head
Techniques on body	Techniques movements pointed to the body

The study observed four types of hand attacks: kizami tsuki (straight punch), Gjaku tsuki (reverse punch), kizami tsuki gjaku tsuki Judan (straight punch and reverse punch to the face), and kizami tsuki gjaku tsuki Chudan (straight punch and reverse punch to the face to the trunk). The five kick technique models, Mavasi geri (roundhouse kick); Ura mavasi geri (inside circular leg); Usiro ura mavasi geri (reverse roundhouse kick); Ushiro geri (back kick); and Kekume geri (lateral leg technique), and the ten combination attack models.

Scoring strategy

During official karate competition, matches are disputed between two competitors under strict rules, but athletes are free to move, kick and punch in defensive and offensive manners. There are several ways to earn points in karate, such as offensive and defensive. Based on the technical and tactical ability, the athlete chooses the right method for each competition according to their opponent. In the offensive method, the athlete attempts to score points with a single direct attack, a double direct attack, or combined attacks. While in the defensive method, the player chooses the best reaction to the opponent's attack. In this method, we can refer to techniques such as a direct counterattack, blocking the opponent's attack, defending, or emptying the opponent's attack and attacking from the player's side. The second method has its own dimensions, and the player must choose the most accurate response in the most accurate time possible compared to the opponent's activity. Sports fight rules in karate set the following values: 1 point (Yuko); 2 points (Waza-ari); and 3 points (Ippon). Ippon is scored for leg kicks to the head and the techniques of throwing, which result in

a final fall of the opponent or a final punch. Waza-ari is scored for kicks to the trunk. Finally, Yuko is awarded for single arm punches to the head and body (world karate Federation, 2019).

Data analysis

Video analysis methods using actual data that can be recorded with the ability to analyse slow movements were used to precisely distinguish between techniques. The statistical sample consisted of six karate athletes who reached the finals in the Olympic Games (-67, -75, and +75 categories), and the different techniques used by the silver and gold medallists were evaluated using Dartfish software along with Excel 2015.

Statistical analyses

In order to analyse the data, in addition to using descriptive statistic indicators (prevalence and percentage frequency), nonparametric tests were used (Fisher's exact test, the likelihood ratio test, and Pearson's chi-square test) for data analysis.

RESULTS

Numerical and percent analysis for each one of the technical and tactical factors was conducted in actual combat, and the results are presented in Tables (2,4,6,8,10,12).

Comparison of hand techniques

Table 2 illustrates the difference of the 116 attacks carried out using hand techniques, in 25 instances (21.6%) the athlete succeeded in getting points and in 91 instances (78.4%) failed to get points. Among the four implemented models, kizami tsuki (front hand punch) has the highest score with 15 successful attacks (32.2%) out of 48 executed moves. Furthermore, kizami tsuki (41.4%) was the most used method among four hand technique models in the 116 executed hand techniques.

Table 2. Frequency of hand attacks and success rate.

Hands Technique	Frequency Success				Total	
	Yes		No			
Kizami tsuki	15	32.2 %	33	68.8 %	48	41.4 %
Gjaku tsuki	6	23.1 %	20	76.9 %	26	22.4 %
Kizami tsuki gjaku tsuki Judan	2	6.2 %	30	93.8 %	32	27.6 %
Kizami tsuki gjaku tsuki Chudan	2	20 %	8	80 %	10	8.6 %
Total	25	21.6 %	91	78.4 %	116	100 %

Table 3. Test results of the success rate of hand technique attack.

	Value	df	Sig	Sig	Monte Carlo	
					99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson's Chi-Square	7.152	3	0.047	0.048	0.045	0.056
Likelihood Ratio	8.227	3	0.042	0.047	0.044	0.055
Fisher's Exact Test	7.606			0.046	0.040	0.051
Linear-by-Linear Association	4.758	1	0.029	0.035	0.030	0.040

Table 3 illustrates the difference in the effectiveness of scoring points among the four models is statistically significant, with Fisher's exact test = 7.606, likelihood ratio = 8.227, and Pearson chi-square = 7.152 ($p =$

.047). Therefore, it can be concluded that among the four manual technique models, the kizami tsuki model has the highest number of attacks and is the most successful model for gaining points.

Comparison of kick techniques

What percentage of the various kick attacks used by the top six athletes in the Olympic games in 30 competitions were scoring attacks? (Table 4).

Table 4. Frequency of kick attacks and success rate.

Kick attack	Frequency of Success				Total	
	Yes		No			
Mavasi geri	8	15.7 %	43	84.3 %	51	66.2 %
Ura mavasi geri	1	7.7 %	12	92.3 %	13	16.9 %
Kekume geri	2	22.2 %	7	77.8 %	9	11.7 %
Usiro ura mavasi geri	1	25 %	3	75 %	4	5.2 %
Ushiro geri	0	0 %	0	0 %	0	0 %
Total	12	15.6 %	65	84.4 %	77	100 %

Of the total attacks, 21.6% of cases succeeded in scoring and 91 cases (78.4%) failed, as seen in Table 4. Out of 77 attacks executed using five-foot techniques, 12 equivalent cases (15.6%) succeeded in scoring and 65 equivalent cases (84.4%) failed. Among the five implemented models, the most used method among the five-foot technique models was Mavasi geri (66.2% of 77 executed movements).

Table 5 details the difference in the success of scoring among the five models, $p = .756$, Fisher's Exact test = 1.692, likelihood ratio = 1.242, Pearson's chi-square = 1.187, is not statistically significant. Therefore, it can be concluded that among the five-foot technique models, Mavasi geri was the most used method of attack by the six athletes; However, there was no significant difference in the number of attacks leading to scoring using these techniques.

Table 5. Success rates of the kick attack techniques.

	Value	df	Sig	Sig	Monte Carlo	
					99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson's Chi-Square	1.187	3	0.756	0.774	0.763	0.785
Likelihood Ratio	1.242	3	0.743	0.882	0.874	0.890
Fisher's Exact Test	1.692			0.639	0.627	0.651
Linear-by-Linear Association	0.207	1	0.649	0.730	0.718	0.741

Combination techniques

We examined the combined attacks executed by the winning players in the Olympic tournament (Table 6).

Combination technique (Table 6), 7 instances (30.4%) succeeded in scoring and 16 cases (69.6%) failed. Among the 10 implemented models, Throwing & tsuki was had the highest number with 3 successful attacks (60% out of five executed moves), and was the most used method among the 10 combination technique models (21.74% of 23 executed moves).

Table 7 illustrates the difference in the success of scoring among the models, $p = .748$, Fisher's Exact test = 6.172, likelihood ratio = 7.674, Pearson's chi-square = 5.918, is not statistically significant. Therefore, it can

be concluded that among the 10 combination technique models, throwing & tsuki had the highest score with three successful performances; however, the number of attacks leading to scoring using these techniques did not have a significant difference.

Table 6. Frequency of combination attacks and success rate.

Hands T	Frequency Success				Total	
	Yes		No			
Kizami tsuki gjaku tsuki Chudan & Judan	1	50%	1	50%	2	8.69%
Mavasi geri & Ura mavasi geri	0	0%	2	100%	2	8.69%
Double Mavasi geri	1	50%	1	50%	2	8.69%
Gjaku tsuki & Mavasi geri	0	0%	1	100%	1	4.34%
Kizami tsuki & Ura mavasi geri	0	50%	1	50%	1	4.34%
Mavasi geri & Gjaku tsuki	1	33.3%	2	66.7%	3	13.04%
Kizami tsuki gjaku tsuki Judan & Mavasi geri	0	0%	1	100%	1	4.34%
Kizami tsuki gjaku tsuki Judan & gjaku tsuki Judan	1	25%	3	75%	4	17.39%
Kizami tsuki & Mavasi geri	0	0%	2	100%	2	8.69%
Throwing& tsuki	3	60%	2	40%	5	21.74%
Total	7	30.4%	16	69.6%	23	100%

Table 7. Success rate of combination technique attacks.

	Value	df	Sig	Monte Carlo		
				Sig	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson's Chi-Square	5.918	9	0.748	0.906	0.898	0.913
Likelihood Ratio	7.674	9	0.567	0.914	0.906	0.921
Fisher's Exact Test	6.172			0.948	0.942	0.953
Linear-by-Linear Association	0.264	1	0.607	0.618	0.605	0.630

Comparison of hand, kick, and combination attacks

The three different attack models were examined and checked their frequency and their success in scoring points.

As seen in Table 8, of the 216 executed attacks, 49 cases (22.69%) succeeded in scoring and 167 cases (77.31%) failed. Among the three types of executed attacks, hand attacks had the highest frequency (53.70% of the 216 executed attacks).

Table 8. Frequencies of hand, kick, and combination attacks and success rate.

Type of Attack	Frequency Success				Total	
	Yes		No			
Hands	30	25.86%	86	74.14%	116	53.70%
Kicks	12	15.58%	66	85.72%	77	35.65%
Combination	7	30.43%	16	69.57%	23	10.65%
Total	49	22.69%	167	77.31%	216	100%

Models shown in Table 9, is not statistically significant ($p = .16$, Fisher's Exact test = 3.827, likelihood ratio = 3.794, Pearson's chi-square = 3.669). Therefore, it can be concluded that among the three implemented

models, although combination attack had the highest score with 30.43% successful attacks, the number of attacks leading to scoring using these three models did not have a significant difference.

Table 9. Success rate of hand, kick, and combination technique attacks.

	Value	df	Sig	Monte Carlo		
				Sig	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson's Chi-Square	3.669	2	0.16	0.163	0.153	0.172
Likelihood Ratio	3.794	2	0.15	0.156	0.146	0.165
Fisher's Exact Test	3.827			0.14	0.131	0.149
Linear-by-Linear Association	0.208	1	0.649	0.721	0.71	0.733

Comparison of the frequency of the attacks at different time points

Out of the 216 executed attacks (Table 10), 49 cases (22.7%) succeeded in scoring and 167 cases (77.3%) failed. Among the three time points, the third minute had the highest frequency of attacks with 98 attacks (45.4% of 216 executed attacks).

Table 10. Frequency of the attacks at different time points.

Time	Frequency Success				Total	
	Yes		No			
First Minute	12	24.00%	38	76.00%	50	23.1%
Second 1 minute	14	20.59%	54	79.41%	68	31.5%
Third 1 minute	23	23.47%	75	76.53%	98	45.4%
Total	49	22.7%	167	77.3%	216	100%

The difference in the frequency of attacks (Table 11) in three times points is not statistically significant ($p = .881$, Fisher's Exact test = 0.281, likelihood ratio = 0.257, Pearson's chi-square = 0.254). Therefore, it can be concluded that the third minute had the highest number of executed attacks with 98 attacks among the three different time points. However, the number of attacks leading to scoring during these three time points did not have a significant difference.

Table 11. Success rate of attacks at different time points.

	Value	df	Sig	Monte Carlo		
				Sig	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson's Chi-Square	0.254	2	0.881	0.919	0.912	0.926
Likelihood Ratio	0.257	2	0.879	0.919	0.912	0.926
Fisher's Exact Test	0.281			0.898	0.890	0.906
Linear-by-Linear Association	0.001	1	0.982	0.999	0.995	0.999

Reaction of the six players to the opponent's attacks

The reaction of the six athletes to the opponents' attacks in the Olympic competition showed that dodging (99 times) was the most used defensive reaction to the opponent's attacks, and defence and attack (2 times) was the least used reaction of the finalists to the attacks.

As seen in Table 12, out of 214 reactions, the most frequent reaction was dodging (99 cases). The difference in the type of reaction is statistically significant ($p = .001$, chi-square = 228.64).

Table 12. Frequency of the defensive reactions.

Reaction to opponent attack	Observed N	Expected N	Chi-Square	df	Sig
Dodge	99	6.30	64.228	6	.001
Dodge & attack	50	6.30			
De-ai	23	6.30			
De-asshi	3	6.30			
Defence	20	6.30			
Defence and attack	2	6.30			
No reaction	17	6.30			
Total	214				

Attack target

Out of 261 attacks, 156 cases (72%) were attacks to the face and 60 cases (28%) were attacks to the trunk (Table 13). The difference in the attack target was statistically significant ($p = .001$, $\chi^2 = 42.57$). Therefore, it can be concluded that between the two targets, the face was the most affected area with 72% of the attacks being targeted to the face.

Table 13. Comparing the two attack target areas.

Attack target	Frequency	Precent	Chi-Square	df	Sig
Face	156	72%	42.57	1	.001
Trunk	60	28%			
Total	216				

Tactics

Out of 104 points earned, in 72 cases (69.2%) the points were obtained through attacking and in 32 cases (30.8%) they were obtained through a counterattack (Table 14). The difference in scoring using both tactics is statistically significant ($p = .001$, chi-square = 15.39). Therefore, it can be concluded that among the two types of scoring tactics, attacking was the most successful tactic for scoring.

Table 14. Comparison of the two tactics in scoring points.

Score tactics	Frequency	Precent	Chi-Square	df	Sig
Attack	72	69.2%	15.39	1	.001
Counterattack	32	30.8%			
Total	104				

DISCUSSION

This study, different attack models were investigated: single attack (hand and kick attacks) and combined attacks (punch and kicks or kick and punches), the frequency and percentage of successful attacks, the most hit area of the body, the highest scoring time point in the match, and the intensity of the time in terms of the frequency of attacks, and the most performed reaction to the opponent's attacks. Several studies on performance analysis in combat sports have found that successful athletes tend to use more strategy while attacking compared to unsuccessful athletes. Previous research on kickboxing athletes found that successful

athletes more often using attacking techniques, such as a hook punch and double punch, and blocking techniques attacks compared to unsuccessful athletes (Ouerqui et al., 2013). This study showed that 6 finalist athletes were able to score more by attacking compared to that while performing a counterattack. However, that does not necessarily mean that the athlete who attacks more in each game will win the game but means that karate attacks need more accuracy. Moreover, if the 104 points obtained by the six finalists are examined, it can be seen that 72 points (69.2%) were obtained by attacking and only 32 points (30.8%) were obtained by counterattacks. This indicates the superiority of the six finalists in being aggressive and in choosing the right technique at the right time. This agrees with (Koropanovski & Jovanovic, 2008) who reported that the achieved score by attack was (52.54%) but counterattack was (23.55%). The findings demonstrated that upper limb techniques (53.70%) were used more than lower limb (35.65%) and combination techniques (10.65%). These results are in accordance with the those of the study conducted by (Helmi Chaabene et al., 2014) who demonstrated that upper-limb techniques (76.19%) are used more frequently than lower-limb techniques (23.80%) in Karate. Koropanovski and Jovanovic (2008) demonstrated that punches have a higher frequency (89.09%) compared to kicks (8.36%). The study conducted in 2020 reported that out of 602 attacks, 422 attacks (70.1%) were made using hands and 180 attacks (29.9%) were made using legs, which is agreement with the results of previous studies (Tabben et al., 2018; Laird & McLeod, 2009). The lower frequency kicking techniques may be explained by the longer lane and time, as well as the time it takes to perform them in relation to punches (Mudric, 2001). In this study, among the four hand techniques the Kisami-tsuki represented 41.4% of the upper-limb attack techniques and was the most frequently used upper limb technique. While Kisami-tsuki & giaku tsuki chudan with 8.6% was the least used technique. These data agree with those of previous studies (Chaabene et al., 2014; Jovanovic & Milosevic, 1992; Alinaghipour & Zareian, 2020) which suggested the predominance of the kizamazuki upper-limb technique. Kizami tsuki was the most predominantly used technique to score, with 32.2% of the points received by the six athletes were gained using this technique, which agrees with the results obtained by a previous study (Alinaghipour & Zareian, 2020) that found that the kizami tsuki technique as the most frequently used scoring technique. The Kizami tsuki punch has the shortest time required to perform compared to the other techniques and requires the shortest line to beat opponents. The shortest time of performing is necessary; the punch gjaku tsuki is 150 ms and kizami tsuki 110 ms (Jovanovic & Milosevic, 1992). However, it is important to emphasize that the data were obtained in a laboratory when the athletes performed the techniques themselves. The mawashi geri kick technique with a frequency of 66.2% was the most used technique among five kick attack models, which agrees with the results obtained by previous studies (Koropanovski & Jovanovic, 2008; Laird & McLeod, 2009; Romanovitch, 2020) that found the mawasi geri technique as the most applicable technique.

The study found that throwing & tsuki had the highest frequency among the 10 combination techniques used by the six fighters with a frequency of 21.74%. Moreover, it was most successful combination technique.

Regarding the target attack areas (the head or trunk), out of the 216 completed attacks by the six fighters, 72% were made to the opponents face and only 28% towards the opponent's trunk. The head and face are parts that are most likely to be affected by attacks compared to the trunk. These results agree with previous study (Reza, S et al., 2021), which showed that 76.7% of the attacks were to the head and 23.3% were to the trunk. However, they disagree with the results of a study by Laird & McLeod (2009) who showed that 54% of the attacks were targeted to the opponent's trunk and only 35% were to the opponent's face and head, while 11% were to the penalty area. The reason for fewer attacks on the opponent's body can be because this area of the body is guarded the opponent's hands (guard), or that the athlete needs to lower his height and rotate their waist and shoulder more when performing an attack on this area of the body, making

it more difficult and riskier. Attacks to this area of body compared to those at the head and face, require more skill and more exercise.

Different times had different intensities. The third minute, with 45.4% of attacks, was the highest intensity time in the competition, while the first minute, with 23.1% attacks, was the lowest intensity. These results agree with those of our previous study, in the third one minute with 46.7% attack was the most intense duration in world championships and world karate league competitions in 2018 and 2019, and the first minute with 18.4% attacks was the least intense duration (Reza, S et al., 2021). This indicates that in the first minute, the players are getting to know each other and are finding the right target to attack and are strategizing the exact time to execute it. Additionally, in the last minute, if the player is tied with or losing to their opponent, he will use all his ability to win the game, and thus, tends to attack more.

Among the reactions of the six fighters to the 214 attacks made by the opponent, dodging was most frequent reaction, which was performed 99 times by the six athletes in the Olympic Games, followed by dodge and attack, while defend and attack was the least frequent reaction by the players in the Olympic Games. Our previous study showed that counterattack and dodging were the most used reactions by world karate champions during competitions. Additionally, defence and attack had the least alternation among the different reactions, which necessitates a separate study.

CONCLUSION

The findings of this study are particularly relevant for karate technicians, researchers, coaches, and professional athletes. In summary, karate athletes tend to use upper-limb techniques far more than lower-limb techniques. In particular, the difference in the points scored using the two tactical models of attack and counterattack was significant and 69.2% of the points were scored by attacking.

The main conclusions drawn from the video analysis indicate that there is a significant difference in the frequency of the techniques used to score in competitive karate competitions. Furthermore, the results suggest a clearly predominant scoring technique. The Kisami-tsuki model was used to make the highest number of attacks and is the most successful model for scoring points because it has the fastest execution time. The most frequent reaction was dodging, which was performed 99 times and the difference in the reaction types is statistically significant. Finally, we believe that the results of this observational study will assist karate coaches to further their knowledge on technical and tactical performance in karate competitions. Especially that related to the use and efficiency of various attack techniques and tactics.

Limitations and future research lines

With respect to the limitations of this study, the extent to which outcomes were generalized or externally valid was based only on the six finalists (Olympic athletes). Other studies should consider expanding to and analysing a larger sample-size to identify the extracted models. Further studies that focus on the performance of athletes at various levels of competition, consider the match result, and include more items to provide more data are required to validate the results of this study.

AUTHOR CONTRIBUTIONS

Conceptualization, R.S., and D.Z. Methodology, R.S., and D.Z. Formal analysis, R.X.F. Data curation, R.S., and D. Z. Writing – original draft preparation, R.S. and D.A. Writing – review and editing, D.A., M.T and P.I.

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No potential conflict of interest was reported by the authors.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available upon request to the corresponding author.

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