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Comprehensive technical analysis of a kickboxing fight in K1 format based on observation

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Comprehensive technical analysis of a kickboxing fight in K1 format based on observation

Abstract

Introduction: Observation and specialized analysis of confrontations in combat sports are fundamental for introducing corrections in training programs and for modifying the individual technical-tactical profiles of athletes in these types of activities. These actions comprehensively assess the progress of sports activities, ultimately inspiring and guiding the direction of training in sports clubs. The aim of this study was to analyze and assess the level of the offensive structure of Kickboxing sport fights in the K1 format, in terms of global simulated sparring, in selected thematic sets. **Materials and Methods:** The research material consisted of a multimedia recording of 10 simulated K1 sparring sessions, in which 20 professional athletes of this discipline participated (age: 24.5 ± 4.6 years; body height: 179.1 ± 4.6 cm; body weight: 81.7 ± 9.9 kg; BMI: 25.5 ± 3.7 ; training experience: 6.9 ± 1.3 years). To assess the offensive structure of the fight, a retrospective analysis of the recorded empirical material was conducted in terms of the quantity of attacks made, and then specialized technical-tactical preparation (PTT) indicators were calculated, in the global context of sparring, for thematic sets (total; punches vs kicks; right vs left limb attacks; type of techniques; direction of attack). **Results:** The analysis revealed a significantly higher technical-tactical efficiency regarding hand strikes, left hand, and direction of strikes to the opponent's head in terms of activity ($p < 0.001$), effectiveness ($p < 0.001$), and efficiency ($p = 0.008-0.408$) of attack. In isolated analysis of kicking techniques, a significant advantage in efficiency was registered for selected attacks directed at the lower parts of the opponent's body, i.e., torso, legs ($p = < 0.001-0.043$). The most effective and exploited techniques were: left straight (Aa $\bar{x}=36.8$; Sa $\bar{x}=23.9$), and for kicks, right low kick (Aa $\bar{x}=14.9$; Sa $\bar{x}=5.6$). The highest attack efficiency was noted for the right middle kick (Ea $\bar{x}=54.18$). Several selected comparative sets (inter-limb symmetry, type of attack, direction of attack) for technical-tactical efficiency, were characterized by significant statistical differentiation ($p = < 0.001-0.048$). **Conclusions:** Kickboxing is an asymmetrical combat sport, which necessitates the application of targeted training on individual body segments of the athlete, and compensatory actions in the prevention of injuries. The study results allow for detailed diagnosis and interpretation of the technical-tactical profile along with the key manifestation of offensive competencies in Kickboxing profession in the K1 format, favoring the optimization of the quality of coaching control.

Keywords

combat sports, offensive fight analysis, technical-tactical indicators, Kickboxing K1.

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Article

Comprehensive technical analysis of a kickboxing fight in K1 format based on observation

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Abstract: Introduction: Observation and specialized analysis of confrontations in combat sports are fundamental for introducing corrections in training programs and for modifying the individual technical-tactical profiles of athletes in these types of activities. These actions comprehensively assess the progress of sports activities, ultimately inspiring and guiding the direction of training in sports clubs. The aim of this study was to analyze and assess the level of the offensive structure of Kickboxing sport fights in the K1 format, in terms of global simulated sparring, in selected thematic sets. Materials and Methods: The research material consisted of a multimedia recording of 10 simulated K1 sparring sessions, in which 20 professional athletes of this discipline participated (age: 24.5 ± 4.6 years; body height: 179.1 ± 4.6 cm; body weight: 81.7 ± 9.9 kg; BMI: 25.5 ± 3.7 ; training experience: 6.9 ± 1.3 years). To assess the offensive structure of the fight, a retrospective analysis of the recorded empirical material was conducted in terms of the quantity of attacks made, and then specialized technical-tactical preparation (PTT) indicators were calculated, in the global context of sparring, for thematic sets (total; punches vs kicks; right vs left limb attacks; type of techniques; direction of attack). Results: The analysis revealed a significantly higher technical-tactical efficiency regarding hand strikes, left hand, and direction of strikes to the opponent's head in terms of activity ($p < 0.001$), effectiveness ($p < 0.001$), and efficiency ($p = 0.008–0.408$) of attack. In isolated analysis of kicking techniques, a significant advantage in efficiency was registered for selected attacks directed at the lower parts of the opponent's body, i.e., torso, legs ($p = < 0.001–0.043$). The most effective and exploited techniques were: left straight (Aa $\bar{x}=36.8$; Sa $\bar{x}=23.9$), and for kicks, right low kick (Aa $\bar{x}=14.9$; Sa $\bar{x}=5.6$). The highest attack efficiency was noted for the right middle kick (Ea $\bar{x}=54.18$). Several selected comparative sets (inter-limb symmetry, type of attack, direction of attack) for technical-tactical efficiency, were characterized by significant statistical differentiation ($p = < 0.001–0.048$). Conclusions: Kickboxing is an asymmetrical combat sport, which necessitates the application of targeted training on individual body segments of the athlete, and compensatory actions in the prevention of injuries. The study results allow for detailed diagnosis and interpretation of the technical-tactical profile along with the key manifestation of offensive competencies in Kickboxing profession in the K1 format, favoring the optimization of the quality of coaching control.

Keywords: combat sports, offensive fight analysis, technical-tactical indicators, Kickboxing K1.

1. Introduction

The analysis of fights in combat sports is a classic activity of conducting coaching control. Through its detailed observation, we can assess the quality of the athletes' techniques and eliminate potential errors [1, 2]. In many combat sports organizations, coaching controls are systematically carried out based on recordings of athletes. In organizations such as UFC or many boxing organizations, quantitative technical summaries are systematically presented between rounds. This provides an overall picture of a given athlete's performance. From a scientific perspective, coaching control has been extended in various ways. In boxing, observations and assessments of the effectiveness of techniques have often been made [3, 4]. Boxing fights were also verified from a technical-tactical perspective, differentiating between winning and losing athletes [5]. Technical-tactical observations were also made in karate [6–8]. During numerous implementations of coaching controls based on recordings of matches, researchers developed technical-tactical preparation indicators, which were initiated in the analysis of Judo fights [9–11]. These were used, among other things, for comparisons of technical-tactical actions during changes in Judo fighting rules [12]. The development of technical-tactical preparation indicators led to the creation of formulas for use in kickboxing fights in the K1 format [13]. A scale of indicators was also developed, allowing for precise determination of the technical-tactical level in K1 format fights [14]. Kickboxing fights in the K1 format are characterized by high dynamics [15]. K1 rules, among all the competitive formats presented by the World Association of Kickboxing Organizations (WAKO), have the least regulatory restrictions. This means that athletes exchange punches and kicks with maximum force during fights. Initial observations of matches show to what extent athletes receive direct hits [16, 17] and how often fights end prematurely [18]. In kickboxing, among the hand techniques, classic boxing punches (straight punch, hook, uppercut) can be distinguished, as well as additional techniques like the spinning backfist and jumping punch. Among the leg techniques, the following can be distinguished: front kick, side kick, roundhouse kick, hook kick, down-ward kick, spinning kick, and knee strikes [19]. Amateur kickboxing fights last 3 rounds of 2 minutes each [20, 21], presenting comprehensive technical exchanges. As mentioned earlier, in K1 fights, frequent observations of matches were made, determining indicators of activity, efficiency, and effectiveness of attacks. However, comprehensive observations have not been conducted regarding which specific techniques are most frequently used by athletes and which are most often successful. According to the rules, each clean hit during a fight scores 1 point, regardless of the attack zone. To fill the gap in knowledge, the aim of this work was to conduct a comprehensive technical analysis of kickboxing fights in the K1 format based on the observation of a match. In conducting the observations, answers were sought to the questions:

- What technique is most commonly used by kickboxing athletes?
- What foot technique is most commonly used by athletes?
- What hand technique is most commonly used by athletes?
- Which technique most often succeeds?

Based on the coaching and competitive experience of the authors, the following hypothesis was formulated: athletes most often execute a straight front punch and a low roundhouse kick, while the low roundhouse kick most often succeeds.

2. Material and methods

2.1. Research material

The research material consisted of multimedia recordings of 10 simulated K1 sparring sessions, in which 20 professional athletes of this discipline participated (age: 24.5 ± 4.6 years; body height: 179.1 ± 4.6 cm; body weight: 81.7 ± 9.9 kg; BMI: 25.5 ± 3.7 ;

training experience: 6.9 ± 1.3 years). To evaluate the offensive structure of the fight, a retrospective analysis of the recorded empirical material was conducted in terms of the quantity of attacks made, and then specialized technical-tactical preparation (PTT) indicators were calculated, in the global context of sparring, for thematic sets (total; punches vs kicks; right vs left limb attacks; type of techniques; direction of attack).

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Bioethics Committee at the Regional Medical Chamber (No. 287/KBL/OIL/2020).

2.2. Technical-tactical preparation indicators

The analysis of the sports fight was performed based on the digital recording of the match made using a camera. Based on the recordings, technical-tactical training indicators were determined by applying established formulas [1].

Efficiency of the attack (S_a)

$$S_a = \frac{n}{N}$$

n – numbers of attacks awarded 1 pt.*

* In K1 formula each fair hit is awarded 1 pt.

N – number of bouts

Effectiveness of the attack (E_a)

$$E_a = \frac{\text{number of effective attacks}}{\text{number of all attacks}} \times 100$$

*An effective attack is a technical action awarded a point

* Number of all attacks is a number of all offensive actions

Activeness of the attack (A_a)

$$A_a = \frac{\text{number of all registered offensive actions of a kickboxer}}{\text{number of bouts fought by a kickboxer}}$$

2.3. Statistical analysis

In the development of the research results, basic statistical methods were applied, determining the arithmetic mean, standard deviation, minimum value, maximum value, coefficient of variation, and percentage share for selected variables. Assumptions about the normality of the distribution of variables were verified using the Shapiro-Wilk test. The assessment of differences between variables conforming to a normal distribution was made using the t-test for dependent variables. For determining differences between variables deviating from the normal distribution, the Wilcoxon signed-rank test for dependent variables was used. A p-value of less than 0.05 was considered statistically significant. The analysis of the collected material was developed using Statistica software by Statsoft, version 13.3 (Statsoft, Kraków, Poland).

3. Results

In terms of the substantive structure of K1 confrontations, the studied athletes achieved a 40.41% share of successful (scored) attacks out of all used. In terms of quantity, it was found that upper limb strikes were more frequently used (62.40%) and more effective (66.18% share of successful attacks) compared to lower limb kicks. Regarding the

symmetry between upper limbs, the most strikes were delivered with the left hand, with the highest effectiveness (74.56% share of the number of techniques performed with 75.87% effectiveness – calculated from the total techniques and effective techniques for upper limbs). For kicks, the same trend was noted for the right lower limb (55.98% quantity, 59.63% effectiveness). Among the striking techniques used, the left straight punch had the highest activity (50%) and effectiveness (53.66% share of all scored attacks) in terms of quantity. For kicks, this analogy was characterized by the right low kick (33.63% and 34.78%).

The athletes most frequently used attacks directed at the opponent's head, i.e., 1475 times, compared to 881 directed at the torso (465) or lower limbs (416) of the opponent, which translated into 580 successful hits to the head (562 punches and 18 kicks), while 372 hits were recorded to the torso (204) and legs (168). In an isolated comparison, a similar trend was observed in terms of the number of hand strikes (1326 head vs 144 torso) with strike effectiveness: 562 head vs 68 torso. However, kicks were predominantly used on lower body parts, i.e., 321 to the torso and 416 to the opponent's legs (737 torso, legs vs 149 head), with effectiveness of 304 torso, legs vs 18 head. Table 1 presents detailed characteristics of quantitative sets of applied attacks for Kickboxing confrontations in the K1 format.

Table 1. Quantitative summary of applied attacks, in the global and segmental context for K1 fights.

Variable	Effective	Non-effective	Total
Global Summary			
Offensive actions (n=20)	952	1404	2356
Segmental summary with division into punches and kicks			
Punches, (n=20)	630	840	1470
Kicks (n=20)	322	564	886
Symmetry summary with division into left and right limbs			
Left hand strikes (n=20)	478	618	1096
Right hand strikes (n=20)	152	222	374
Left leg kicks (n=20)	130	260	390
Right leg kicks (n=20)	192	304	496
Segmental summary with division into punch techniques			
Left straight punch (n=20)	338	398	736
Right straight punch (n=20)	74	98	172
Left hook (n=20)	126	186	312
Right hook (n=18)	54	102	156
Left uppercut, (n=8)	14	32	46
Right uppercut (hak), (n=6)	12	10	22
Left Spinning Backfist (n=2)	0	2	2
Right Spinning Backfist (n=6)	12	12	24
Segmental summary with division into targets of punch techniques			
Left straight high (n=20) vs Left straight middle (n=12)	300 vs 38	366 vs 32	666 vs 70
Right straight high (n=20) vs Right straight middle (n=12)	62 vs 12	86 vs 12	148 vs 24

Variable	Effective	Non-effective	Total
Left hook high (n=20) vs Left hook middle (n=14)	112 vs 14	158 vs 28	270 vs 42
Right hook high (n=18) vs Right hook middle (n=6)	50 vs 4	98 vs 4	148 vs 8
Segmental summary with division into kick techniques			
Left low roundhouse kick (n=16)	56	62	118
Right low roundhouse kick (n=18)	112	186	298
Left middle roundhouse kick (n=20)	34	74	108
Right middle roundhouse kick (n=20)	40	42	82
Left high roundhouse kick (n=12)	4	34	38
Right high roundhouse kick (n=10)	6	30	36
Left spinning kick (n=2)	0	2	2
Right spinning kick (n=16)	14	30	44
Left front kick (n=16)	30	72	102
Right front kick (n=16)	10	12	22
Left knee strike (n=10)	6	16	22
Right knee strike (n=6)	10	4	14
Segmental summary with division into targets of kick techniques			
Right spinning hook kick high (n=12) vs Right spinning hook kick middle (n=15)	3 vs 11	17 vs 13	20 vs 24
Left front kick high (n=13) vs Left front kick middle (n=16)	2 vs 28	34 vs 38	36 vs 66
Right front kick high (n=8) vs Right front kick middle (n=14)	0 vs 10	8 vs 4	8 vs 14
Left knee strike high (n=4) vs Left knee strike middle (n=8)	1 vs 5	5 vs 11	6 vs 16
Right knee strike high (n=2) vs Right knee strike middle (n=6)	2 vs 8	1 vs 3	3 vs 11

Regarding attack activity (Aa), the indicators showed a significant preference for the use of upper limb strikes and left-hand strikes. Among the attacks, the left straight punch was the most utilized technique. In terms of punch direction, a significant differentiation was found with a predominance of attacks aimed at the opponent's head. Regarding kicks, the highest activity was shown for the right low kick. In terms of direction, an opposite trend to punches was observed, with most kicks being directed at the opponent's torso and legs.

Comparative analysis showed significant differentiation for selected sets, which are detailed in Table 2.

Table 2. Summary of Attack Activity Indicators, in the global and segmental context for K1 fights

Variable	\bar{x}	sd	min	max	CV%	P value
Global Summary						
Offensive actions	117.80	30.35	80.00	196.00	25.77	-
Segmental summary with division into punches and kicks						
Punches	73.50	22.94	39.00	127.00	31.21	<0.001
Kick	44.30	15.24	23.00	69.00	34.40	
Symmetry summary with division into left and right limbs						
Left hand strikes	54.80	16.02	32.00	89.00	29.23	<0.001
Right hand strikes	18.70	9.20	7.00	38.00	49.20	
Left leg kicks	19.50	15.47	1.00	46.00	79.32	0.108
Right leg kicks	24.80	7.74	10.00	39.00	31.22	
Segmental summary with division into punch techniques						
Left straight punch	36.80	11.22	21.00	62.00	30.48	<0.001
Right straight punch	8.60	5.07	1.00	17.00	58.98	
Left hook	15.60	11.36	3.00	39.00	72.83	0.002
Right hook	7.80	5.06	0.00	17.00	64.92	
Left uppercut (hook)	2.30	4.84	0.00	16.00	210.23	0.074
Right uppercut (hook)	1.10	2.17	0.00	7.00	197.64	
Left Spinning Backfist	0.10	0.31	0.00	1.00	307.79	0.028
Right Spinning Backfist	1.20	1.94	0.00	5.00	161.32	
Segmental summary with division into targets of punch techniques						
Left straight high vs Left straight middle	33.3 vs 3.50	8.4 vs 3.59	21 vs 0	52 vs 10	25.2 vs 102.6	<0.001
Right straight high vs Right straight middle	7.4 vs 1.20	4.2 vs 1.2	1 vs 0	15 vs 3	56.6 vs 99.7	<0.001
Left hook high vs Left hook middle	13.5 vs 2.1	9.2 vs 2.4	3 vs 0	32 vs 7	67.7 vs 114.5	<0.001
Right hook high vs Right hook middle	7.4 vs 0.4	4.5 vs 0.7	0 vs 0	15 vs 2	61.1 vs 170.1	<0.001
Segmental summary with division into kick techniques						
Left low roundhouse kick	5.90	5.24	0.00	17.00	88.82	0.014
Right low roundhouse kick	14.90	8.75	0.00	33.00	58.71	
Left middle roundhouse kick	5.40	4.68	1.00	15.00	86.73	0.248
Right middle roundhouse kick	4.10	5.14	1.00	15.00	125.34	
Left high roundhouse kick	1.90	2.07	0.00	6.00	109.21	0.875
Right high roundhouse kick	1.80	2.28	0.00	6.00	126.94	
Left spinning kick	0.10	0.31	0.00	1.00	307.79	<0.001
Right spinning kick	2.20	1.70	0.00	5.00	77.48	
Left front kick	5.10	6.95	0.00	24.00	136.28	0.003
Right front kick	1.10	0.72	0.00	2.00	65.29	

Variable	\bar{x}	sd	min	max	CV%	<i>p</i> value
Right Spinning Backfist	0.60	1.05	0.00	3.00	174.38	
Segmental summary with division into targets of punch techniques						
Left straight high vs Left straight middle	15 vs 1.9	6,9 vs 2.1	6 vs 0	27 vs 6	46 vs 109.2	<0.001
Right straight high vs Right straight middle	3,1 vs 0.6	2,4 vs 0.8	0 vs 0	8 vs 2	77,6 vs 136.8	<0.001
Left hook high vs Left hook middle	5.6 vs 0.7	5.2 vs 1	0 vs 0	17 vs 3	92 vs 147.3	<0.001
Right hook high vs Right hook middle	2.5 vs 0.2	2.1 vs 0.4	0 vs 0	5 vs 1	82.6 vs 205.2	<0.001
Segmental summary with division into kick techniques						
Left low roundhouse kick	2.80	2.86	0.00	9.00	102.07	0.018
Right low roundhouse kick	5.60	3.35	0.00	10.00	59.76	
Left middle roundhouse kick	1.70	2.11	0.00	7.00	123.83	0.836
Right middle roundhouse kick	2.00	2.51	0.00	8.00	125.66	
Left high roundhouse kick	0.20	0.41	0.00	1.00	205.20	0.463
Right high roundhouse kick	0.30	0.66	0.00	2.00	218.98	
Left spinning kick	0.00	0.00	0.00	0.00	0.00	0.002
Right spinning kick	0.70	0.66	0.00	2.00	93.85	
Left front kick	1.50	2.98	0.00	10.00	198.83	0.347
Right front kick	0.50	0.51	0.00	1.00	102.60	
Left knee strike	0.30	0.47	0.00	1.00	156.72	0.263
Right knee strike	0.50	0.83	0.00	2.00	165.43	
Segmental summary with division into targets of kick techniques						
Right spinning hook kick high vs Right spinning hook kick middle	0.2 vs 0.6	0.4 vs 0.5	0 vs 0	1 vs 1	244.2 vs 92.8	0.025
Left front kick high vs Left front kick middle	0.1 vs 1.5	0.3 vs 2.7	0 vs 0	1 vs 9	299.5 vs 185.7	0.005
Right front kick high vs Right front kick middle	0.00 vs 0.5	0.00 vs 0.5	0.00 vs 0	0.00 vs 1	0.00 vs 102.6	0.005
Left knee strike high vs Left knee strike middle	0.1 vs 0.3	0.2 vs 0.4	0 vs 0	1 vs 1	447.2 vs 177.7	0.142
Right knee strike high vs Right knee strike middle	0.1 vs 0.4	0.3 vs 0.7	0 vs 0	1 vs 2	307.8 vs 170.1	0.068

The attack efficiency indicators (E_a), which represent the ratio of successful actions to all executed actions, showed a similar result profile to Aa and Sa. An exception was the technique of kicks, where the most efficient was found to be the right middle kick. The discussed comparative analyses in relation to Aa and Sa were characterized by a significantly lesser degree of significance in differentiation, which was noted only in relation to selected sets: symmetry and techniques of kicks, techniques of punches, and direction of attack (Table 4).

Table 4. Summary of Attack Efficiency Indicators, in the global and segmental context for K1 fights

Variable	\bar{x}	sd	min	max	CV%	<i>p value</i>
Global Summary						
Offensive actions	40.55	8.24	29.09	60.19	20.32	-
Segmental summary with division into punches and kicks						
Punches	42.11	9.19	27.38	58.75	21.84	0.386
Kicks	38.66	15.10	8.16	65.22	39.06	
Symmetry summary with division into left and right limbs						
Left hand strikes	42.68	11.93	25.37	65.63	27.96	0.348
Right hand strikes	39.48	7.17	28.57	50.00	18.17	
Left leg kicks	27.89	12.24	0.00	43.48	43.88	0.048
Right leg kicks	40.20	18.92	3.45	68.18	47.06	
Segmental summary with division into punch techniques						
Left straight punch	47.21	16.11	25.64	73.53	34.12	0.218
Right straight punch	37.42	22.92	0.00	75.00	61.26	
Left hook	35.94	18.16	0.00	66.67	50.54	0.221
Right hook	25.51	18.44	0.00	50.00	72.29	
Left uppercut (hook)	7.08	14.57	0.00	37.50	205.64	0.123
Right uppercut (hook)	19.29	33.43	0.00	100.00	173.34	
Left Spinning Backfist	0.00	0.00	0.00	0.00	0.00	0.028
Right Spinning Backfist	14.83	25.41	0.00	75.00	171.33	
Segmental summary with division into targets of punch techniques						
Left straight high vs Left straight middle	45.8 vs 31.7	18.5 vs 27.4	19.4 vs 0	75 vs 66.7	40.4 vs 86.4	0.093
Right straight high vs Right straight middle	36.2 vs 28.3	23.5 vs 37.5	0 vs 0	75 vs 100	64.8 vs 132.4	0.408
Left hook high vs Left hook middle	37.2 vs 17.6	21.1 vs 22.6	0 vs 0	75 vs 50	56.7 vs 128.2	0.008
Right hook high vs Right hook middle	25.4 vs 15	18.8 vs 32.9	0 vs 0	55,6 vs 100	74 vs 219	0.158
Segmental summary with division into kick techniques						
Left low roundhouse kick	35.51	19.96	0.00	60.00	56.21	0.940
Right low roundhouse kick	38.11	25.86	0.00	80.00	67.86	
Left middle roundhouse kick	20.08	17.89	0.00	46.67	89.07	0.010
Right middle roundhouse kick	54.18	42.88	0.00	100	79.15	
Left high roundhouse kick	4.17	8.76	0.00	25.00	210.26	0.463
Right high roundhouse kick	5.33	11.36	0.00	33.33	213.06	
Left spinning kick	0.00	0.00	0.00	0.00	0.00	<0.001
Right spinning kick	30.83	32.00	0.00	100.00	103.79	
Left front kick	16.39	18.62	0.00	50.00	113.62	0.070
Right front kick	35.00	40.07	0.00	100.00	114.47	

Variable	\bar{x}	sd	min	max	CV%	<i>p value</i>
Left knee strike	21.43	40.54	0.00	100.00	189.18	0.779
Right knee strike	25.00	41.36	0.00	100.00	165.43	
Segmental summary with division into punch techniques						
Right spinning hook kick high vs Right spinning hook kick middle	9.2 vs 42.5	25.1 vs 43.8	0 vs 0	100 vs 100	273.4 vs 103	0.029
Left front kick high vs Left front kick middle	1.2 vs 27.2	3.6 vs 33.3	0 vs 0	12.5 vs 100	308.4 vs 122.3	0.005
Right front kick high vs Right front kick middle	0.00 vs 45	0.00 vs 51	0.00 vs 0	0.00 vs 100	0.00 vs 113.4	<0.001
Left knee strike high vs Left knee strike middle	5 vs 17	22.4 vs 36.3	0 vs 0	100 vs 100	447,2 vs 213,5	0.208
Right knee strike high vs Right knee strike middle	7.5 vs 24.2	24.5 vs 41	0 vs 0	100 vs 100	326.2 vs 169.6	0.080

4. Discussion

The research using scientific observation on kickboxing fights in the K1 format reveals interesting aspects of dynamics and preferred techniques in this discipline [1]. Characteristic of K1, the high dynamics and direct confrontation require athletes to have not only proper physical preparation but also a strong psychological background [2]. In this format, the rules are designed to promote direct combat, which translates into the necessity of continuous engagement in the fight and minimizing the avoidance of confrontation [3, 22].

The study results indicate that upper limb strikes are more frequently used (62.40%) and are more effective (66.18% share in effective attacks) compared to lower limb kicks. This may be due to the greater speed and ease of executing such strikes, as well as the ability to keep the opponent at a distance, which is crucial in such a dynamic form of fighting [5]. Straight punches, often delivered with the leading hand, allow controlling the fighting space, keeping the opponent at a distance, and preventing them from effectively launching an attack [6].

The dominant left position among athletes means that the left upper limb was the most exploited (74% share of all strikes delivered with hands), making the left straight one of the most commonly used and effective techniques (50% share in all punches). This observation leads to a qualitative conclusion about the need for focused training of this body segment with a priority in the area of strength and speed endurance. Equally important are actions to compensate for asymmetry in injury prevention.

Additionally, observations indicate frequent targeting of strikes, especially hand strikes, towards the opponent's head (1475 out of 2356 total strikes). This strategy aims to quickly end the fight by knockout or technical knockout [6]. This points to the need for training intervention in the special defense of this body part. Thematic reports [6] and this study (580 strikes that made direct contact with the head out of 952 all scored) illustrate how many strikes land on a fighter's head. Therefore, there is also a need for specialized, preventive diagnostics to illustrate any abnormalities [10–12].

In the category of leg techniques, the highest efficiency was noted for the low roundhouse kick (low kick), usually performed with the right leg. Such attacks are aimed at weakening the opponent by targeting their legs, limiting their mobility and ability to move around the ring [13, 14]. Low kicks are also economical in terms of energy expenditure, allowing athletes to use them more frequently during fights [15, 23].

In a detailed characterization of the technical-tactical profile of the studied athletes, specialized formulas were used, which are reliable indicators of this aspect [16]. The global analysis showed that the indicators of activity, effectiveness, and efficiency of attack in our study were lower than those registered among participants and medallists of World Championships but exceeded those presented by participants and finalists of local tournaments. Moreover, the recorded attack activity was higher than that noted among finalists of the Polish Championships, albeit with lower effectiveness and efficiency [18, 19]. It is worth noting that the presented study of technical-tactical PTT assessment, with division into symmetry sets between limbs, type and direction of attack in our research, in our opinion, had not yet been used in the environment of striking combat sports, and certainly not with personalized diagnosis for Kickboxers – K1. To our knowledge, we are the first to describe the aforementioned profile.

The discussion of these results highlights the importance of specific techniques in K1 and suggests that training should focus on developing skills related to the most effective and frequently used techniques, such as the left straight and right low kick. However, it is also important to develop other techniques to prevent becoming predictable to opponents and to maintain versatility in combat [20].

It is also worth mentioning the middle roundhouse kick, which records high efficiency in this study. Such techniques are directed towards the ribs and liver, increasing their effectiveness. These results also confirm analyses in Muay Thai, where such techniques are frequently used [24].

Study Limitations

Our study had several limitations, including a relatively small number of observed kickboxing fights in the K-1 format, and the operation in the area of simulated sparring. However, in light of the inevitable limitations of our experimental project, we recruited professional K1 athletes, procedures were conducted according to a strict protocol, and the results are scientifically justified. Future actions should include expanding the study to the environment of tournament fights with a larger number of matches, and additionally, to show the multi-faceted context of the problem, a division into weight categories should be made.

5. Conclusions

Kickboxing in the K1 format is an asymmetrical combat sport, necessitating the application of targeted training on individual body segments and model techniques of athletes, as well as compensatory actions in the prevention of asymmetry. K1 athletes are particularly vulnerable to receiving head strikes, necessitating the optimization of defensive actions for this body part and preventative, specialized diagnostics.

Practical Implications

The study results allow for detailed diagnosis and interpretation of the technical-tactical profile along with the key manifestation of offensive competencies of the Kickboxing profession in the K1 formula, which helps optimize the quality of coaching control and can set the direction of training in sports clubs.

References

1. Wi M. Tactical skills in kickboxing bouts according to K1 rules. *Biology*. 2022;11(1):1–10.
2. Hendley ED, Moisset B, Welch BL. Catecholamine uptake in cerebral cortex: Adaptive change induced by fighting. *Science*. (1979)1973;180:1050–2. DOI: 10.1126/science.180.4090.1050
3. World Association of Kickboxing Organizations WAKO K1-Rules. WAKO; 2020.
4. Boyanmis AH, Akın M. Effectiveness of plyometric or blood flow restriction training on technical kick force in taekwondo. *Balt J Health Phys Act*. 2022;14(1):Article5. DOI: 10.29359/BJHPA.14.1.05

5. Ouergui I, Delleli S, Bouassida A, Bouhlel E, Chaabene H, Ardigò LP, et al. Technical-tactical analysis of small combat games in male kickboxers: Effects of varied number of opponents and area size. *BMC Sport Sci Med Rehabil.* 2021;13:158. DOI: 10.1186/s13102-021-00391-0
6. Lambert C, Beck BR, Weeks BK. Concurrent validity and reliability of a linear positional transducer and an accelerometer to measure punch characteristics. *J Strength Cond Res.* 2018;32:675–80. DOI: 10.1519/JSC.0000000000002284
7. Rydzik Ł, Wąsacz W, Ambroży T, Pałka T, Sobilo-Rydzik E, Kopańska M. Comparison of head strike incidence under K1 rules of kickboxing with and without helmet protection—A pilot study. *Int J Environ Res Public Health.* 2023;20:4713. DOI: 10.3390/ijerph20064713
8. Kopańska M, Ochojska D, Muchacka R, Dejniewicz-Velitchkov A, Banaś-Ząbczyk A, Szczygielski J. Comparison of QEEG findings before and after onset of post-COVID-19 brain fog symptoms. *Sensors.* 2022;22:6606. DOI: 10.3390/s22176606
9. Adam M. A Profile of Adriana Dadci's Individual Technical-Tactical Preparation. *Balt J Health Phys Act.* 2012;4(1):35–43. DOI: 10.2478/v10131-012-0005-0
10. Adam M, Tyszkowski S, Smaruj M. The Contest Effectiveness of the Men's National Judo Team of Japan and Character of Their Technical-Tactical Preparation during the World Judo Championships 2010. *Balt J Health Phys Act.* 2011;3(1):65–74. DOI: 10.2478/v10131-011-0007-3
11. Rydzik Ł. Fitness profile of oyama karate and kickboxing athletes – Initial concept. *Arch Budo Sci Mart Arts Extr Sport.* 2021;17:19–24.
12. Rydzik Ł. Determination of the real training load based on monitoring of K1 kickboxing bouts. *Antropomotoryka.* 2022;100:1–8. DOI: 10.5604/01.3001.0016.0606
13. Slimani M, Chaabene H, Miarka B, Chamari K. The activity profile of elite low-kick kickboxing competition. *Int J Sports Physiol Perform.* 2017;12:182–9. DOI: 10.1123/ijssp.2015-0659
14. Krupalija E, Kapo S, Raão I, Ajnadžip N, Simonovič D. Structural analysis of the situational efficiency in the kickboxing disciplines full contact and low kick. *Homo Sporticus.* 2010;12:36–40.
15. Ouergui I, Hammouda O, Chtourou H, Zarrouk N, Rebai H, Chaouachi A. Anaerobic upper and lower body power measurements and perception of fatigue during a kick boxing match. *J Sports Med Phys Fitness.* 2013;53:455–60.
16. Rydzik Ł, Niewczas M, Kędra A, Grymanowski J, Czarny W, Ambroży T. Relation of indicators of technical and tactical training to demerits of kickboxers fighting in K1 formula. *Arch Budo Sci Martial Arts Extr Sport.* 2020;16:1–5.
17. Rydzik Ł, Ilbak I, Ouergui I, Podrighalo L, Pałka T. Analysis of cortisol concentration changes induced by stress in kickboxing K1 competition. *J Spors Res Innov.* 2024; 1–8.
18. Rydzik Ł. Indices of technical and tactical training during kickboxing at different levels of competition in the K1 formula. *J Kinesiol Exerc Sci.* 2022;32:1–5. DOI: <https://doi.org/10.5604/01.3001.0015.7542>
19. Ambroży T, Rydzik Ł, Kwiatkowski A, Spieszny M, Ambroży D, Rejman A, et al. Effect of CrossFit training on physical fitness of kickboxers. *Int J Environ Res Public Health.* 2022;19:4526. DOI: 10.3390/ijerph19084526
20. Ambroży T, Rydzik Ł, Kędra A, Ambroży D, Niewczas M, Sobilo E, et al. The effectiveness of kickboxing techniques and its relation to fights won by knockout. *Arch Budo.* 2020;16:11–17.
21. Nikolaïdis P, Fragkiadiakis G, Papadopoulos V, Karydis NV. Differences in Force-Velocity Characteristics of Upper and Lower Limbs of Male Kickboxers. *Balt J Health Phys Act.* 2011;3(3):147–153. DOI: 10.2478/v10131-011-0014-4
22. Romanenko V, Iermakov S, Podrigalo L, Rovnaya O, Sotnikova-Meleshkina Z, Goloha V, Ruban L. Analysis of interrelations of psychophysiological and physiological indicators of martial arts athletes. *Balt J Health Phys Act.* 2019;11(4):58–68. DOI: 10.29359/BJHPA.11.4.07
23. Wąsik J, Ortenburger D, Góra T. Studies of kicking of three targets – does sex differentiate the velocity of the taekwondo front kick? *Balt J Health Phys Act.* 2019;11(1):76–82. DOI: 10.29359/BJHPA.11.1.08
24. Cimadoro G, Mahaffey R, Babault N. Acute neuromuscular responses to short and long roundhouse kick striking paces in professional muay Thai fighters. *J Sports Med Phys Fitness.* 2019; 59(2): 204–9. DOI: 10.23736/S0022-4707.18.08295-6

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