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Ending an MMA combat bout: specific striking techniques which determine the type of outcome

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Abstract

Background. A schematic analysis of tactical performance by an MMA athlete is a potential mediator of success, and can help the understanding of how striking actions can be used to organize technical-tactical actions. A specific evaluation of MMA striking actions has not been undertaken in previous studies.

Problem and aim. To compare the striking motor actions of MMA athletes by outcome type (Split vs. Unanimous Score Decision vs. KO/TKO vs. Submission) at the Ultimate Fighting Championship (UFC™), and to offer a practical application for MMA training.

Methods. Kruskal Wallis and Dunn *post hoc* tests were applied to compare the effects of the different types of outcome decision (Split Score Decision vs. Unanimous Score Decision vs. KO/TKO vs. Submission).

Results. Results showed a higher number of Unanimous than Split Decisions and Submissions after attempted ($p \leq 0.05$) and ($p \leq 0.05$) landed head strikes during keeping distance and clinch moments. A Split Decision followed a higher frequency of attempted ($p \leq 0.05$) and landed ($p \leq 0.05$) body strikes during keeping distance and clinch moments rather than an Unanimous Decision. Submission and TKO/KO.TKO/KO were more highly demonstrated than Split Decision after Attempted [0.0 (0.0;2.0); $p \leq 0.05$)] and Landed [0.0 (0.0;2.0); $p \leq 0.05$)] Head Jabs during groundwork combat.

Conclusions. These results are interesting because they show the singularities of two situations (Split and Unanimous Scores) in which the bout must continue until the end of the round. Unanimous decisions were made in respect of attacks to the head during stand up combat, while split decisions were determined by the number of strike actions oriented to the body, and TKO/KO outcomes were determined by jabs to the head made in the ground situation.

Introduction

The tactical aspects of MMA bouts may be affected by the outcome method (referee's decision, knockout and submission), which may interfere in technical-tactical patterns (i.e. frequency of striking and groundwork actions) in detailed situations [Kirk *et al.* 2015]. Specific striking analysis can be separated into three phases:

a) keeping distance; b) clinch and; c) groundwork [Miarka *et al.* 2017]. In the keeping distance phase, the athletes keep their distance, at which time both athletes are able to organize their strategies and movements and are not limited by body contact or the other person's grip [Kruyning De Jong 2014]. In this phase, the athletes keep their distance to avoid sequential attacks by the opponent, attempting to use mainly full single punches, kicks, and knee and elbow attacks [Chernozub *et al.* 2018; Coswig *et al.* 2016]. During the clinch phase both athletes attempt to perform specific punches, kicks, and knee and elbow attacks. They move to the final, ground phase, through strike sequences, by trying to dominate the opponent for then doing submissions with strike attacks or grappling actions, such as chokes and joint and locking techniques, as soon as possible [Kruyning De Jong 2014]. It is to the benefit of coaches and high-level support athletes to understand the potential of relating the striking characteristics in each combat phase rather than the previously-labeled style of athletes (*i.e.* grapplers versus strikers. This understanding can assist in the design of better training programs [Blue 2016].

A schematic analysis of striking performance by MMA athletes may be helpful, and may be applied to observe the actions taken by the competitor to increase their chances of winning relative to the specific situation and the technical-tactical actions in each method of ending a round. [Chernozub *et al.* 2018]. These actions involve a diverse skill set including: varied strike actions with different orientation (i.e. Head, Body, Leg); with spatio-temporal changes (i.e. keeping distance, clinch and ground), while the relationship between these skills represents the primary aspects of MMA attacking systems [Chernozub *et al.* 2018; Coswig *et al.* 2016].

Further, technical-tactical data from different situations can offer crucial information to improve contextualized training plans with potentially unknown key factors [Coswig *et al.* 2016]. However, it is not clear whether the technical-tactical aspects would increase the probability of being a winner by using specific striking actions as the means of ending rounds. The authors have been attempting to determine those performance indicators that have the greatest influence on classifying outcome at the elite level of MMA and establishing the efficacy of decision tree analysis in explaining the characteristics of victory when compared to alternate statistical methods. Grappling and accuracy performance indicators were considered the most influential ones in explaining outcomes [James *et al.* 2017]. Although, this report provides important information for athletes and coaches, we believe that MMA athletes require specific analysis of the technical-tactical actions associated with striking competitive success.

Even if the athlete stands up takes place into that striking category, however, the precise techniques to develop a strategic way to attack and to know when, what and how to orientate strike attempts and land them on the opponent might not be clear to coaches and athletes [James *et al.* 2017]. A specific evaluation of MMA striking actions comparing round-ending methods has not been performed. This analysis can increase the variety of strategies, allowing MMA athletes to make the best strike actions choices during the combat. This is an essential point because this combat sport has a higher number of strike actions of special complexity of intermittent structure over the five minutes per round, which involve striking skills (*i.e.* punches, kicks, knees and elbows attacks directed to the head, body and leg) as well as grappling actions (*i.e.* takedowns, submissions, chokes and locks) [Kirk *et al.* 2015; Tack 2013]. The identification of differences in round-ending methods as a potential mediator of success could help to understand how striking actions could be used to organize technical-tactical actions in order to quickly adapt to spatial-temporal changes during the round [Miarka *et al.* 2018]. Therefore, the purpose of the study was to do an objectivity performance analysis based on striking actions in different MMA combat phases (i.e. keeping distance, clinch and ground) comparing outcome types (TKO/KO, Submission, Unanimous and Split Score Decision).

Methods

Study design

This comparative and descriptive applied research study, using technical-tactical analysis, determined specific striking actions by referee's decision by elite level athletes participating in UFC®. This information provides new concepts of performance evaluation and programs to the specific combat phase of each outcome. A validated protocol of technical-tactical analysis was identified in previous studies addressing MMA performance analysis [Kirk *et al.* 2015; James *et al.* 2017]. The data collected from professional events in sequence was analyzed. All bouts occurred during UFC events in air-conditioned arenas, except Ibirapuera Gym, between 18:30 and 24:00 with temperature range between 24.5-27.0ºC. In the last stage of the study, we compared types of outcomes (TKO/KO, Submission, Unanimous Score Decision and Split Score Decision) to verify the impact of each technical-tactical grappling action.

This study was submitted to and approved by the Local Committee of Ethics in Research, following the rules of resolution 196/96 of the National Health Council. The present study ensured anonymity and confidentiality by replacing the athletes' personal identification. In addition, there are no ethical issues in analyzing or interpreting data obtained at public events, as established by previous protocols [Kirk *et al.* 2015; James *et al.* 2017; Coswig *et al.* 2018].

Participants

The sample was composed of 304 UFC rounds, the sample was separated by Split Score Decision (n= 40), Unanimous Score Decision (n = 170), KO/TKO (n = 54) and Submission (n = 40) from 58 events between 2012 and 2014 (UFC-TUF Finale 16-19; UFC 152-174, UFC Fight Night 28-50; UFC on Fox 3-11; UFC on FUEL TV 4-7). A minimum of six weeks of rest was observed between bouts to prevent stress interference between different combats [James *et al.* 2013]. All participants had previous experience in professional UFC events and of the rules and procedures used during the championships. No interference was made to the training, nutritional or hydration status of participants and they maintained the weight loss recovery time pattern of 24 hours between Official weigh-in and the bout, following UFC rules [Jetton *et al.* 2013; Matthews Nicholas 2016]. The criteria for inclusion were to consider only bouts with three rounds (including knockout, technical knockout, submission and score decisions), while the exclusion criteria concerned bouts with more than three rounds and/or with characteristics that disqualified prospective outcomes comparisons – bouts which finished in "draw" or "no contest".

Protocol of striking actions analysis, intra and inter-expert validation

Striking actions were subdivided into four data categories, according to the situation utilized 1) general results (*i.e.* Knockdowns, total strike actions attempted and landed, frequencies of single strike actions attempted and landed directed to head, leg and body) 2)by including keeping distance determinant for striking actions (*i.e.* Knockdowns, total strike actions attempted and landed, frequencies of single strike Jabs and Power actions attempted and landed directed to head, leg and body), 3) Clinch determinant striking actions (*i.e.* Knockdowns, total strike actions attempted and landed, frequencies of single strike Jabs and Power actions attempted and landed directed to head, leg and body) and 4)ground work determinant striking actions (*i.e.* total strike actions attempted and landed, frequencies of single strike Jabs and power actions attempted and landed directed to head, leg and body) [Kirk *et al.* 2015].

Technical-tactical action changes were observed by five researchers, according to the frequency of actions, following a previously established protocol [Miarka *et al.* 2017]. In order to guarantee ecological validity and to verify the elite status of the sample, the bouts were analyzed by a team of five analysts using recordings of professional quality and filmed by performance analysts. All available videos of sufficient quality (standard definition 480/60i) and taken in landscape format with a view of the entire competition area, were included in the analysis. Where appropriate, while considering the inclusion criteria, both athletes were evaluated in a single match, and individual athletes were evaluated more than once when videos of multiple matches were available, following previously published protocols [Sterkowicz-Przybycien *et al.* 2016]. The reliability between measurements obtained for each technical variable was verified with Intra-class coefficient of correlation (ICC) values in preceding reports [Sterkowicz-Przybycien *et al.* 2016].

Statistical Analysis

The Kolmogorov-Smirnov test (K-S) was used to determine the normal distribution of data. The null hypothesis was rejected, with $p \leq 0.05$ for all variables in the present study. Descriptive data of frequency of dependent variables are presented as mean, standard deviation (SD), median, first quartile (1Q) and third quartile (3Q). For this non-parametric data, Kruskal Wallis and Dunn *post hoc* tests were applied to conduct and compare the effects of types of outcome decisions (Split Score Decision vs. Unanimous Score Decision vs. KO/TKO vs. Submission). A significance level of $p \leq 0.05$ was used. All analyses were conducted using SPSS 20.0 for Windows.

Results

Figure 1 presents Strike Frequencies of Total Head Strikes Attempted and Landed actions.

Regarding Keeping distance moment, the statistical analysis showed significant differences between types of outcomes when comparing the Total of Head Strikes Landed actions (X^2=13.990, df=4, $p=0.007$), in which Split Decision demonstrated lower frequency of Head Strikes Landed than Unanimous Decisions ($p=0.027$). For Total of Head Strikes Attempts keeping distance (X^2=20.577, df=4, $p \leq 0.001$), Unanimous Decision demonstrated higher frequency of Head Strikes Attempted actions keeping distance than Split Decision ($p=0.002$) and Submission ($p=0.014$). Regarding Total of Head Strikes Landed actions during clinch situation (X^2=18.111, df=4, $p \leq 0.001$), Unanimous Decision demonstrated higher frequencies than Submission ($p=0.014$) and Split Decision ($p=0.008$). No effects were observed when comparing Total of Head Strikes Attempted ($p=0.195$), and Landed actions ($p=0.245$). Figure 2 presents Strike Frequencies of Total Body Strikes Attempted and Landed actions.

Statistical analysis showed significant differences between types of outcomes when comparing Total of Body Strikes Attempts keeping distance (X^2=10.360, df=4, $p=0.035$), but *post hoc* did not detect effects and; no effects were observed when comparing Total Body

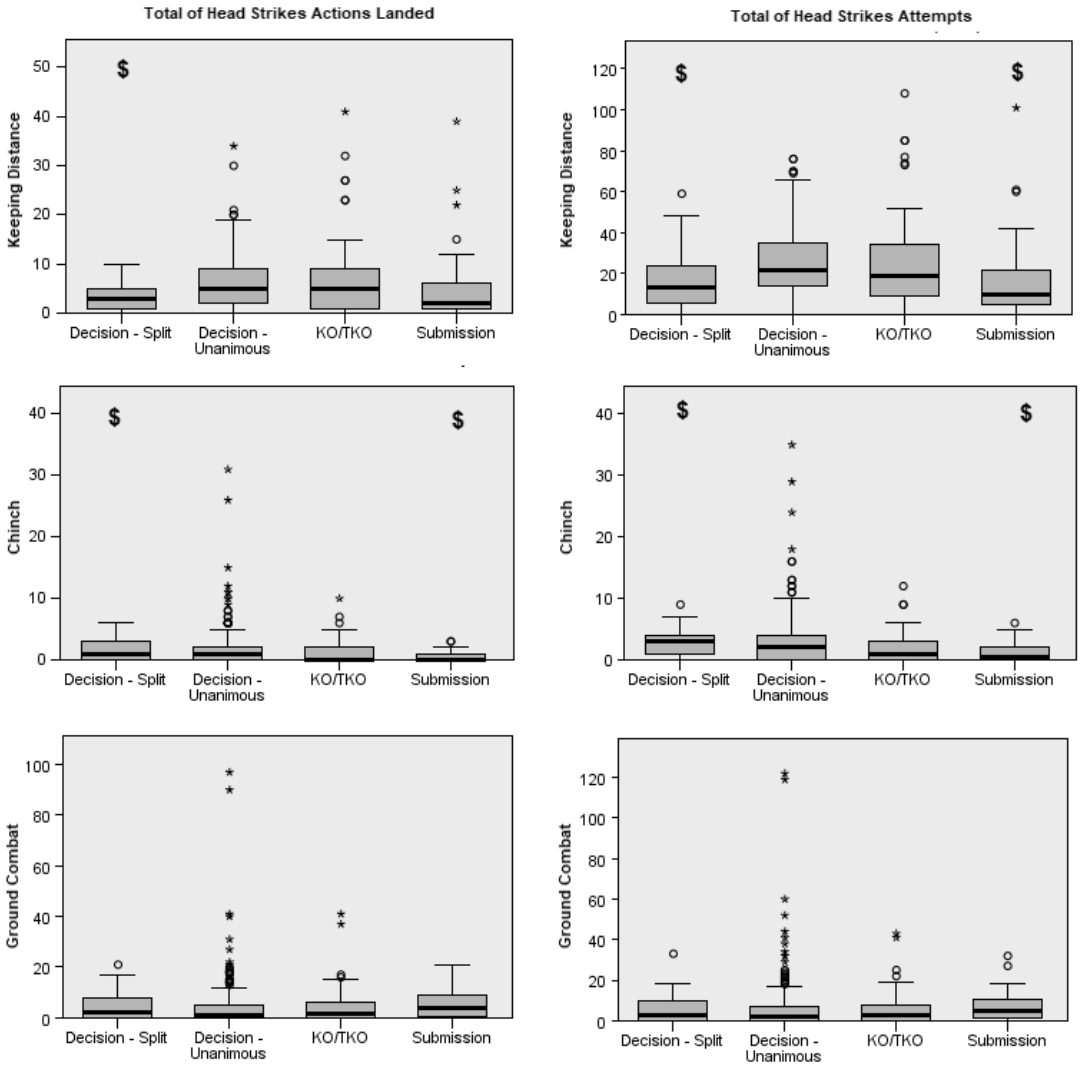

Figure 1. Head Strike Frequencies by each MMA combat situation. $ = significantly different from Unanimous Decision, $p \leq 0.05$. °* – outliers.

Strikes Landed actions ($p=0.182$) keeping distance. Significant differences were observed at clinch moments when comparing Total of Body Strikes Landed actions (X^2=16.077, df=4, $p=0.003$), Split Decision showed higher frequency than Submission ($p=0.006$) and KO/TKO decision ($p=0.023$). When comparing Total of Body Strikes Attempts (X^2=19.221, df=4, $p \leq 0.001$), Split Decision showed higher frequencies than Submission ($p=0.003$), KO/TKO decision ($p=0.003$) and Unanimous Decision ($p=0.010$). No effects were observed when comparing Total of Body Strikes Attempts ($p=0.081$) or Landed ($p=0.085$) in the ground combat situation. Figure 3 presents Strike Frequencies of Total Leg Strikes Attempted and Landed actions.

No effects were observed when comparing outcome types by Total Leg Strikes Landed actions keeping distance ($p=0.987$), Total Leg Strikes Attempts keeping distance ($p=0.987$), Total Leg Strikes Landed actions during clinch moment ($p=0.107$), Total Leg Strikes Attempts during clinch moment ($p=0.102$), Total Leg Strikes Landed actions during ground combat ($p=0.574$) and Total Leg Strikes Attempts during ground combat ($p=0.579$). Table 1 presents standing combat striking actions that occurred during MMA rounds.

Statistical analysis showed significant differences between types of outcomes when Knock Downs frequencies were compared (X^2=36.343, df=4, $p \leq 0.001$), in which KO/TKO demonstrated higher number of Knockdowns than Decision Split ($p \leq 0.001$), Submission ($p \leq 0.001$) and Decision Unanimous ($p \leq 0.001$). Comparing Strikes Landed frequencies (X^2=9.518, df=4, $p=0.049$), however *post hoc* did not show these effects, while analysis showed significant differences between types of outcomes when Strikes Attempt were compared (X^2=21.326, df=4, $p \leq 0.001$), where Submission demonstrated lower strike actions than Decision Unanimous ($p \leq 0.001$).

Regarding the keeping distance moment, the statistical analysis showed significant differences between outcome types in Head Jab Landed frequencies keeping distance (X^2=10.855, df=4, $p=0.028$), but post hoc did

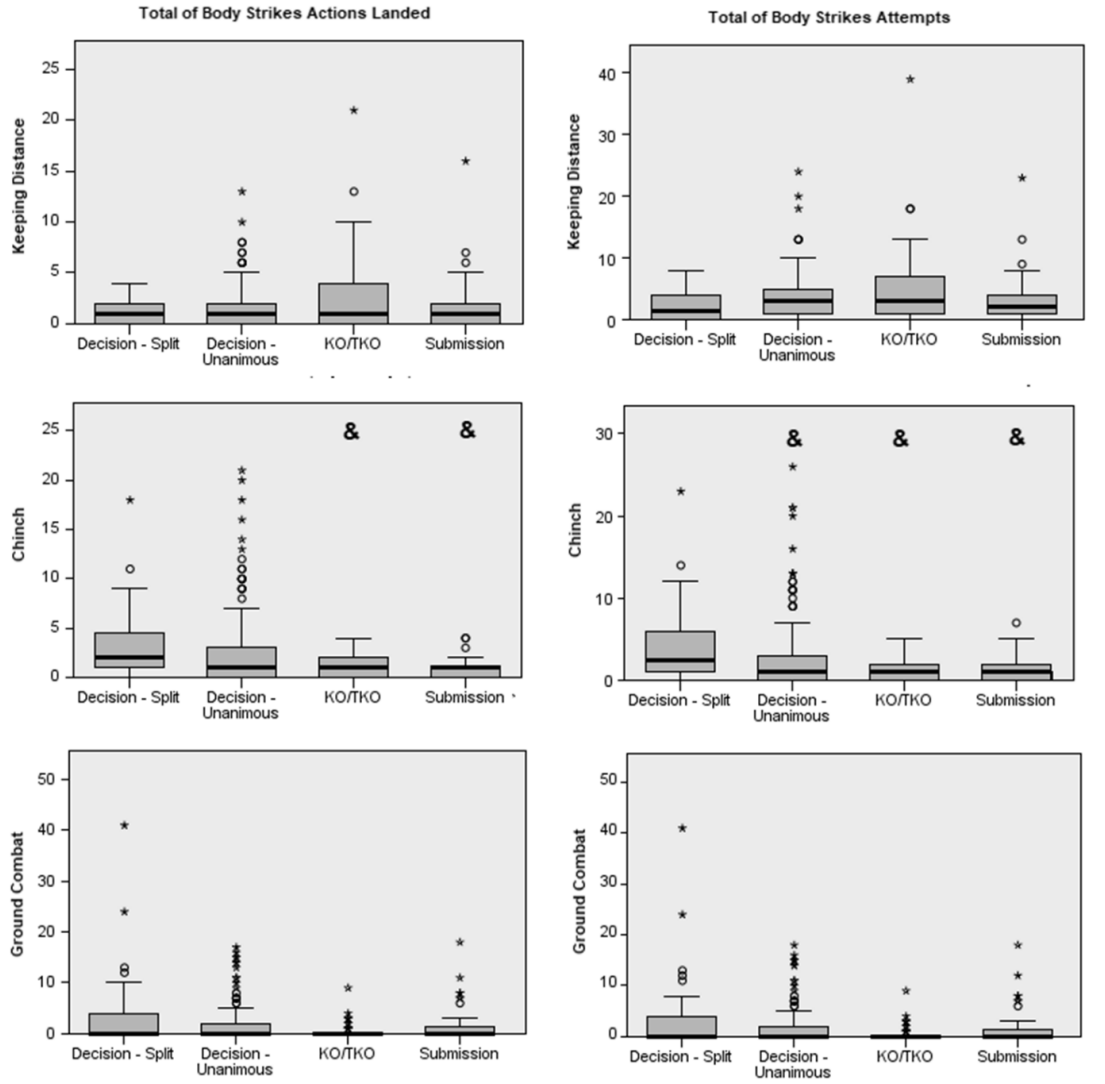

Figure 2. Body Strike Frequencies by each MMA combat situation. & =significantly different from Split Decision, $p \leq 0.05$. °* – outliers.

not show any effects between groups. Analysis showed significant differences between outcome types in Head Jab Attempted frequencies (X^2=15.439, df=4, $p=0.004$), where Unanimous Decision demonstrated higher frequencies than Submission outcome type ($p=0.016$). For Head Power Attempted frequencies keeping distance (X^2=17.574, df=4, $p \leq 0.001$), where Unanimous Decision demonstrated higher frequencies than Submission ($p=0.009$) and Split Decision ($p=0.034$). No effects were observed when compared Head Power Landed ($p=0.068$), Body Jabs Landed ($p=0.068$), Body Jabs Attempted ($p=0.059$), Body Power Landed ($p=0.278$), Body Power Attempted ($p=0.106$), Leg Jabs Landed ($p=0.236$), Body Jabs Attempted ($p=0.304$), Leg Power Landed ($p=0.374$) and Leg Power Attempted ($p=0.600$).

Concerning clinch moment, the analysis presented significant differences between outcome types in Head Power Landed (X^2=17.373, df=4, $p \leq 0.001$), where Submission had lower frequencies than Unanimous Decision ($p=0.004$) and Split Decision ($p=0.023$). Significant differences between outcome types where observed in Head Power Attempts (X^2=22.183, df=4, $p \leq 0.001$), where Submission had lower frequencies than Unanimous Decision ($p=0.003$) and Split Decision ($p=0.014$). For Body Jabs Landed frequencies (X^2=14.650, df=4, $p=0.005$), Submission had lower frequencies than Split Decision ($p=0.006$). Significant differences between outcome types where observed in Body Power Landed (X^2=11.365, df=4, $p=0.023$), where Split Decision had higher frequencies than Submission ($p=0.043$). Analysis presented differences in Body Power Attempts (X^2=15.186, df=4, $p=0.004$), where Split Decision had higher frequencies than Submission ($p=0.010$), KO/TKO outcome ($p=0.008$) and Unanimous outcome ($p=0.044$). No effects were observed when compared Head Jabs Landed ($p=0.286$), Head Jabs Attempted ($p=0.367$), Leg Jabs Landed ($p=0.104$), Body Jabs Attempted ($p=0.126$), Leg Power Landed ($p=0.397$) and Leg Power Attempted ($p=0.411$).

Finally, at the groundwork combat moment, a major effect was observed in the outcome types. It was observed

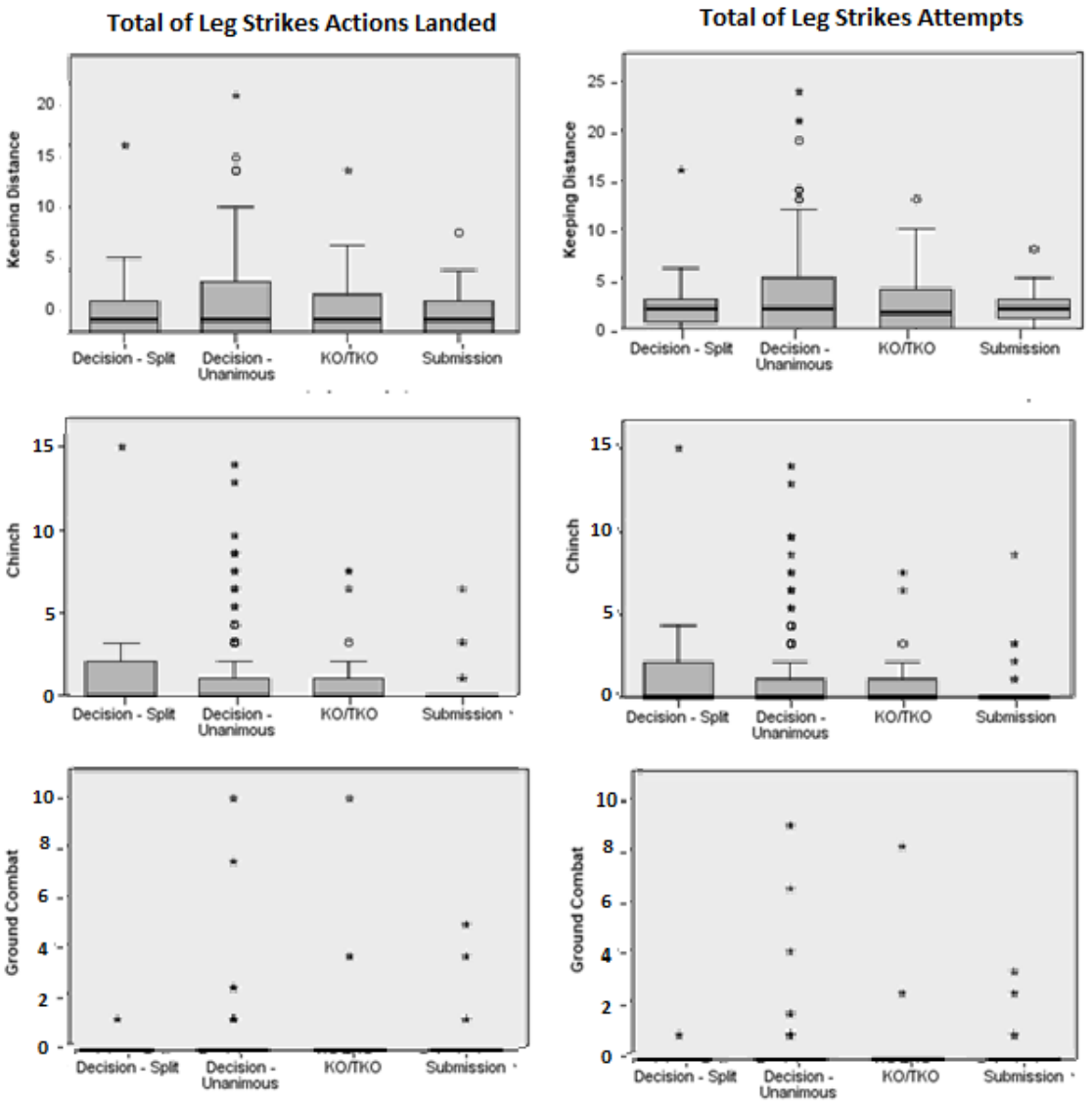

Figure 3. Leg Strike Frequencies by each MMA combat situation. °* – outliers.

in Head Jabs Landed (X^2=10.209, df=4, *p=0.037*), KO/TKO which presented higher frequencies than Submission (*p=0.029*). A significant difference was observed between outcome types, and they were observed in Head Jabs Attempts (X^2=10.837, df=4, *p=0.028*), KO/TKO they presented higher frequencies than Submission (*p=0.026*). No effects were observed when compared to Head Power Landed (*p=0.082*), Head Power Attempted (*p=0.143*), Body Jabs Landed (*p=0.104*), Body Jabs Attempted (*p=0.101*), Body Power Landed (*p=0.691*) and Body Power Attempted (*p=0.710*), Leg Jabs Landed (*p=0.567*), Leg Jabs Attempted (*p=0.568*), Leg Power Landed (*p=0.825*) and Leg Power Attempted (*p=0.825*).

Discussion

This study compared the striking motor actions of male MMA athletes with the outcome types from UFC, leading to a practical application for training. The main results indicated that a higher frequency of Unanimous Decision outcomes following head strikes landed and attempted frequencies rather than Submission and Split Decision during stand up combat (*i.e.* keeping distance and at clinch moment). Split Decision followed a higher frequencies of body strikes landed and attempted rather than Unanimous Decision, Submission and TKO/KO during stand up combat (*i.e.* keeping distance and at clinch moment). When observing each type of action, the other main effect was observed when comparing Head Jab Landed and Attempted during ground combat, with higher frequencies of TKO/KO when compared with Split Decision. Stand up combat where the fighter prevented his/her opponent from achieving grappling actions [Miarka *et al.* 2017] seems to be the best circumstance for bouts that had a higher probability of ending in a Unanimous outcome.

The present evidence indicates that during keeping distance and clinch the athlete who wins by unanimous

Table 1. Standing combat striking actions separated by outcomes.

Motor actions	Split Decision	Unanimous Decision	KO/TKO	Submission
	μ (Q1; Q3)	μ (Q1; Q3)	μ (Q1; Q3)	μ (Q1; Q3)
Knock Downs	0.0 (0.0; 0.0)[#]	0.0 (0.0; 0.0)[#]	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)[#]
Total Strikes Landed	19.5 (10.0; 27.0)	19.0 (12.0; 28.3)	18.5 (9.0; 27.5)	13.0 (8.0; 24.5)
Total Strikes Attempted	37.0 (26.3; 50.5)	46.0 (33.0; 61.3)[@]	37.5 (20.8; 59.8)	27.5 (15.5; 40.8)
Distance phase				
Head Jabs Landed	1.0 (0.0; 2.0)	1.0 (0.0; 3.0)	1.0 (0.0; 3.3)	0.0 (0.0; 2.0)
Head Jabs Attempted	4.0 (2.0; 12.0)	7.0 (4.0; 14.0)[@]	7.0 (1.8; 16.3)	3.0 (1.0; 8.0)
Head Power Landed	2.0 (1.0; 3.8)	3.0 (1.0; 6.0)	3.0 (1.0; 7.3)	1.0 (0.0; 5.0)
Head Power Attempted	9.0 (3.3; 15.0)	13.0 (8.0; 21.5)[@&]	11.0 (4.0; 18.3)	7.0 (2.3; 15.0)
-Body Jabs Landed	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)
Body Jabs Attempted	0.0 (0.0; 0.8)	0.0 (0.0;1.0)	0.0 (0.0;1.0)	0.0 (0.0;1.0)
Body Power Landed	1.0 (0.0; 1.0)	1.0 (0.0; 2.0)	1.0 (0.0; 3.0)	1.0 (0.0; 2.0)
Body Power Attempted	1.0 (0.0; 3.0)	2.0 (1.0; 4.0)	2.5 (1.0; 5.3)	1.5 (0.0; 3.8)
Leg Jabs Landed	0.0 (0.0; 1.0)	0.0 (0.0; 2.0)	0.0 (0.0; 1.0)	0.0 (0.0; 1.0)
Leg Jabs Attempted	1.0 (0.0; 1.8)	1.0 (0.0; 2.3)	0.0 (0.0; 2.0)	1.0 (0.0; 1.0)
Leg Power Landed	0.5 (0.0; 2.0)	0.0 (0.0; 1.0)	1.0 (0.0; 2.0)	1.0 (0.0; 2.0)
Leg Power Attempted	1.0 (0.0 ;2.0)	1.0 (0.0; 2.0)	1.0 (0.0; 3.0)	1.0 (0.0; 2.0)
Clinch Phase				
Head Jabs Landed	0.0 (0.0; 1.0)	0.0 (0.0; 1.0)	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)
Head Jabs Attempted	0.0 (0.0; 1.0)	0.0 (0.0; 1.0)	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)
Head Power Landed	1.0 (0.0; 1.8)[@]	0.0 (0.0; 2.0)[@]	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)
Head Power Attempted	1.5 (0.3; 3.0)[@]	1.0 (0.0; 4.0)[@]	0.0 (0.0; 2.0)	0.0 (0.0; 1.0)
Body Jabs Landed	0.0 (0.0; 2.0)[@]	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Body Jabs Attempted	0.0 (0.0; 2.0)	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Body Power Landed	1.5 (0.0; 3.0)[@]	0.0 (0.0; 2.0)	0.0 (0.0; 1.0)	0.0 (0.0; 1.0)
Body Power Attempted	2.0 (0.3; 4.0)[@]	1.0 (0.0; 3.0)	1.0 (0.0; 2.0)[@]	0.5 (0.0; 1.0)
Leg Jabs Landed	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Leg Jabs Attempted	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Leg Power Landed	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Leg Power Attempted	0.0 (0.0; 1.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)
Ground Phase				
Head Jabs Landed	1.0 (0.0; 4.0)	0.0 (0.0; 3.3)	0.0 (0.0; 2.0)[@]	2.0 (0.3; 6.5)
Head Jabs Attempted	1.5 (0.0; 4.8)	0.0 (0.0; 4.0)	0.0 (0.0; 2.0)[@]	3.5 (1.0; 8.5)
Head Power Landed	0.0 (0.0; 1.8)	0.0 (0.0; 1.0)	0.5 (0.0; 3.0)	0.0 (0.0; 2.0)
Head Power Attempted	1.0 (0.0; 3.8)	0.0 (0.0; 2.0)	1.0 (0.0; 4.3)	1.5 (0.0; 3.8)
Body Jabs Landed	0.0 (0.0; 4.0)	0.0 (0.0; 2.0)	0.0 (0.0; 0.0)	0.0 (0.0; 1.0)
Body Jabs Attempted	0.0 (0.0; 4.0)	0.0 (0.0; 2.0)	0.0 (0.0; 0.0)	0.0 (0.0; 1.0)
Body Power Landed	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)

Note: During ground phase body power attempted, leg jabs landed; jabs attempted; leg power landed and leg power attempted had 0.0 frequencies in all groups analysed; [#] = Significantly different from KO/TKO; [@] = Significantly different from Submission; [&] = Significantly different from Split Decision, $p \leq 0.05$.

decision attacks to the head. This finding is in accord with earlier reports, which indicated that head strikes landed is the best approach to increase the athlete's chance of performing well in a bout [Miarka *et al.* 2018]. In MMA female bouts, the analysis demonstrated a similar number of head strikes attempts 33.9±27.9 frequencies per round, but a higher occurrence in split outcomes, with 49±31.6 frequencies per round [Miarka *et al.* 2016]. Other studies have shown that differences in round-ending and other rounds presented higher values of total strike attempts in male bouts ending in the 1st round with 48.3±2.8 attempts, as compared with bouts finished during the 3rd with 35.2±2.8 strike attempts [Miarka *et al.* 2018]. However, the probability of victory increases in Head Strike Landed Keeping Distance [Miarka *et al.* 2017]. Considering the previous studies and present evidence, the strategy of combats with homogeneous opponents that could result in Unanimous Score may indicate the need to increase the amount of head strikes attempts during two situations: i) keeping distance and in ii) clinch moment.

James *et al.* [2017] indicated a relative difference between winning and losing bouts in strike accuracy of 0.6±1.7 frequencies per minute. Earlier studies suggested that about 77% of bouts were decided during high-intensity striking in standing combat sequences [Coswig *et al.* 2016]. Even so, the present findings show that TKO/KO

are determined during ground combat by jabs directed towards the opponent's head when compared with other types of outcomes. Despite the lower linear and rotational acceleration of a single jab [Fife *et al.* 2017], this present study indicates that attack was decisive for TKO/KO in MMA male bouts. A possible explanation is that the jab is used as a reverse punch to the head during ground combat. Previous reports indicated that a power punch made smaller velocities instantly previously impact than the reverse strike action for the whole-body centre of mass (0.14 vs. 0.31 $m \cdot s^{-1}$), for the arm centre of mass (2.86 vs. 4.68 $m \cdot s^{-1}$), and for the knuckle (4.09 vs. 6.43 $m \cdot s^{-1}$), and the peak force produced by the power strike was minor in the power punch than in the reverse strike action (790 vs. 1450 N) [Gulledge Dapena 2008]. In addition, previous studies found that regional and international MMA bouts ended by submission or KO/TKO focused on Head Strikes Attempts in Advances to Half Guard, Advances to Side, and Advance to Mount positions during ground combat [Coswig *et al.* 2016].

A potential limitation of the motor action analysis described so far is the reliability of the data entry procedure, or the researcher's ability to reproduce the observed value when the measure is constant. Inter-observer consistency is considered essential in forming the reliability of striking analysis [Chaabene *et al.* 2014; Slimani *et al.* 2016; Sterkowicz-Przybycien *et al.* 2016]. The observational-descriptive approach implemented limits and extrapolation of the present findings, which consist of different motor actions and professional athletes may also elicit different physical demands and physiological responses for a specific action and/or combat phase [Coswig *et al.* 2016; James *et al.* 2013].

Sport scientists, coaches and trainers can use such information to understand the coordination dynamics of an MMA athlete's activity upon the striking actions characteristics during training based on types of outcome [Amtmann 2004; Amtmann *et al.* 2008; Chernozub *et al.* 2018]. Well, MMA coaches, explaining only the basics of weight transfer and hip turnover mid-fight during striking actions. For instance, at first, athletes learn how to put the power puncher's full body weight behind the strike, using all parts of the body (legs, abdomen, back, shoulders, and arms) working together in a single smooth motion. In their early stages, athletes learn how to link the larger and more powerful muscle groups of their legs and core to the smaller muscles of the upper torso. There is a tendency to recognize power strike actions associated with the winning outcome, regardless of when and how those actions are taken, but there are unquestionably innate abilities, such as timing, to make decisions that could permit some athletes to strike more precisely than others. Recent findings have indicated that there is no strong correlation between anthropometric and technical-tactical variables, whereas physical fitness variables are a prerequisite for ascendency in this modality [James *et al.* 2017], which indicates that cognitive elements make a significant contribution to the creation of strategies to use striking skills. Slimani *et al.* [2016] observed that mental toughness may be decisive to the outcome of a competition.

Conclusion

The aim of the study was to perform an analysis of striking actions in keeping distance, clinch and during ground combat, comparing types of outcomes (TKO/KO, Submission, Unanimous Score Decision and Split Score Decision). Practical applications focusing on the TKO/KO situation can be based on the ratio of strike actions landed/attempted and on reverse actions in ground combat during training moments or in a tactical plan; Submission could be associated with previous grappling actions demonstrating lower landed and attempted strike actions, which indicates that it could be possible to isolate grappling motor action training. Finally, with higher frequencies of actions, Unanimous Score bouts followed head-oriented attacks during standing combat, while Split Scores resulted from a higher number of body-oriented attacks; this brings up a signal that in hard bouts, when athletes reduce accuracy in head-oriented actions, it is still possible to achieve scores from body-oriented strokes.

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Zakończenie walki w MMA: specyficzne techniki uderzeń, które określają rodzaj wyniku

Słowa kluczowe: badania czasu i ruchu, wykonywanie i analiza zadań, sztuki walki, kontrola ruchowa, trening interwałowy o wysokiej intensywności, wyniki sportowe

Abstrakt

Tło. Schematyczna analiza wyników taktycznych sportowca MMA jest potencjalnym mediatorem sukcesu i może pomóc w zrozumieniu, jak uderzenia mogą być wykorzystane w organizacji techniczno-taktycznych działań. W poprzednich badaniach ta szczegółowa ocena uderzeń w MMA nie została przeprowadzona.

Problem i cel. Porównanie działań uderzeniowych zawodników MMA w sytuacji różnych typów wyników (decyzja dot. wyniku podzielona i decyzja jednogłośna oraz nokaut// techniczny nokaut [KO/TK] i poddanie się) w mistrzostwach *Ultimate Fighting Championship* (UFC™), przeprowadzenie praktycznego zastosowania w treningu MMA.

Metody. Testy *post hoc* Kruskala Wallisa i Dunna zostały zastosowane w celu porównania efektów typów wyników (decyzja dot. wyniku podzielona i decyzja jednogłośna oraz nokaut// techniczny nokaut [KO/TK] i poddanie się).

Wyniki. Wyniki wykazały większą liczbę prób uderzeń głową ($p \leq 0,05$) i udanych uderzeń głową ($p \leq 0,05$) podczas utrzymywania dystansu i momentów klinczujących w sytuacji decyzji jednogłośnej niż w przypadku decyzji podzielonej i poddania się. W przypadku decyzji podzielonej wykazano wyższą częstotliwość prób uderzeń ciała ($p \leq 0.05$) i udanych uderzeń ciała ($p \leq 0.05$) podczas utrzymania odległości i momentów klinczujących niż w przypadku decyzji jednogłośnej, poddania się i nakautów. Nokaut/techniczny nokaut wykazały wyższą częstotliwość prób uderzeń głową [0.0 (0.0;2.0); $p \leq 0.05$)] i udanych uderzeń głową [0.0 (0.0;2.0); $p \leq 0.05$)] podczas walki w parterze niż w przypadku decyzji podzielonej.

Wnioski. Wyniki te są interesujące, ponieważ pokazują cechy szczególne dwóch sytuacji (decyzja dot. wyniku podzielona i decyzja jednogłośna), w których walka musi trwać do końca rund. Jednogłośnie podejmowano decyzje w sytuacji atakach na głowę w czasie walki na stojąco, natomiast decyzje podzielone determinowane były liczbą akcji uderzeniowych zorientowanych na ciało, a wyniki TKO/KO determinowane były uderzeniami w głowę wykonywanymi w czasie walki w parterze.