"IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology",
Vol. 22, no. 2 (2022), pp. 23–31
DOI: 10.14589/ido.22.2.3

COACHING & KINESIOLOGY

Jose Raimundo Fernandes[1(ABCDEFG)], Michele Andrade de Brito[2(BFG)], Ciro Jose Brito[3(ACE)], Esteban Aedo-Munoz[4(CDE)], Bianca Miarka[5(ACF)]

1 ORCID: 0000-0002-2875-9049, Faculty of Physical Education and Sport, Federal University of Juiz de Fora, Juiz de Fora (Brazil)
2 ORCID: 0000-0001-8327-6632, Laboratory of Psychophysiology and Performance in Sports & Combats, School of Physical Education and Sport, Federal University of Rio de Janeiro, Rio de Janeiro (Brazil)
3 ORCID: 0000-0002-2875-9049, Faculty of Physical Education and Sport, Federal University of Juiz de Fora, Juiz de Fora (Brazil)
4 ORCID: 0000-0003-1544-2824 Physical Activity, Sport and Health Sciences Laboratory - Universidad de Santiago, Santiago (Chile)
5 ORCID: 0000-0002-7513-7605, Laboratory of Psychophysiology and Performance in Sports & Combats, School of Physical Education and Sport, Federal University of Rio de Janeiro, Rio de Janeiro (Brazil)

Corresponding author: Jose Raimundo Fernandes
Department of Physical Education Campus of Governador Valadares - R. Manoel Byrro, 241 – Vila Bretas, Governador Valadares - MG, 35032-620, Brazil.
e-mail: mundegv@hotmail.com; Tel.: 33.3301.1000 – 1555

Technical-tactical actions of fighters specialized in striking, grappling, and mixed combat in the Ultimate Fighting Championship®

Submission: 28.07.2020; acceptance: 23.12.2020

Key words: martial arts, grappling, striking, technical-tactical, combat sport

Abstract

Background. This study aimed to describe and analyze the technical-tactical actions used by fighters who had already had experience in striking, grappling, and mixed combat sports when joining the Ultimate Fighting Championship® (UFC®).

Methods. The present research analyzed 384 athletes' performance, classified as grappling, striking, or mixed athletes during combat during their initial performance in UFC® (<3 months) and at a second time, (>6 months of UFC®). The analyzed data compared the striking, grappling, and mixed techniques, $p<0.05$.

Results. Differences were found between groups regarding the percentage of actions, as athletes who entered from mixed combat sports backgrounds used a lower percentage of striking actions, in both the primary [41 (32.3; 51.5); $p\leq0.001$] and secondary [40 (35.3; 46.0); $p\leq0.001$] modules, as well as in grappling techniques [32.0 (17.5; 41.5); $p\leq0.001$]; and high draw outcomes [1.0 (0.0; 3.0); $p\leq0.001$]. For the outcomes, strikers ended the combat by knockout/technical knockout [8.0 (4.0; 11.0); $p\leq0.001$]. For the secondary module, defeat [5.0 (1.0; 10.0); $p\leq0.001$], tie [0.5 (0.0; 2.0); $p\leq0.001$] and referee decision [4.0 (3.0; 7.0); $p\leq0.001$] were predominate in the mixed athletes; knockout/technical knockout [7.0 (4.0; 10.0); $p\leq0.001$] and submission [3.0 (1.0; 6.0); $p\leq0.001$] predominated in strikers.

Conclusions. The present results show that specific technical actions differentiate athletes who previously practiced striking and grappling combat sports. There is special attention given to athletes coming from mixed sports, who had a better pacing strategy but fewer attacks.

Introduction

Mixed Martial Arts (MMA) are a combat sport that incorporates various techniques and skills from different fighting modalities [Robbins, Zemanek Jr 2017; Miarka *et al.* 2019]. MMA's combat modalities classify athletes and actions according to the operational activities as striking, grappling, and mixed [James *et al.* 2017; Coswig *et al.* 2019]. This concept is associated with operationalization. For example, striking sports include Boxing, Kickboxing, Karate, and Taekwondo, as well as others that involve punching, kicking, kneeing, elbowing, and clinching [Drury *et al.* 2017]. Grappling holders include Brazilian Jiu-jitsu, Wrestling, Sambo, and Judo, and incorporate grappling actions, takedowns, joint wrenches/clinches, and submission [James *et al.* 2017; Staack 2019]. Finally, mixed modalities are generally presented as mixed martial arts, include an association between grappling and striking, and comprise combinations of punches, kicks, and grappling to achieve an opponent's submission [Drury *et al.* 2017]. Due to the above, this study seeks to analyze athletes' previous experience in grappling, striking, and mixed combat sports and if the technical-tactical aspects change due to their time in the UFC® competition.

An integration between Technical-Tactical actions (T-T) training level, functional capabilities, and strategies is necessary for each combat and contributes to a greater possibility of success in the fights [Del Vecchio *et al.* 2015; Miarka *et al.* 2019]. On average, 78.3% of MMA fighters choose to use the technical elements of one or two grappling or striking combat sports in which they have greater technical mastery than other actions [Chernozub *et al.* 2018]. In turn, it considerably limits tactical structuring possibilities and decreases their chances of winning compared to 21.7% of fighters who use more diversified techniques [Chernozub *et al.* 2018]. To succeed in MMA, athletes seek to knock out or defeat their opponents, both standing and on the ground, by using striking and grappling techniques [Coswig *et al.* 2019].

Although previous studies on the relationships between the different combat variables are incipient in research in MMA, besides, these studies address specific conditions for grappling or striking actions, leaving scientific gaps in the area [Del Vecchio *et al.* 2015; Miarka *et al.* 2015, 2016; James *et al.* 2016; Kirk 2018]. Some investigations have already superficially analyzed the data and do not offer further details on the variables studied. Others report methodological limitations and scarcity of content [James *et al.* 2018; Kirk 2018; Miarka *et al.* 2018].

However, combat science does not know how important it is to improve techniques according to combat categories in MMA [Miarka *et al.* 2018; Dos Santos *et al.* 2019]. Thus, it is essential to identify which techniques are most prevalent in matching this type of intervention [Kirk 2018; Dos Santos *et al.* 2019]. However, there is a scarcity of studies investigating which actions are determinant in MMA fighters, efficiency. This knowledge about what aspects could be modified due to the length of time competing in UFC® can help coaches and the own modality in its respective evolution. The results of T-T actions can offer essential information to improve the striking, grappling, and mixed categories' training plans and point out which technical actions are most related to this sport's competitive demands. Therefore, we seek to analyze the athletes' previous experience with striking, grappling, and mixed combat sports and whether the aspects of T-T change due to the UFC®. Finally, to offer information to maximize training and achieve a better result in MMA.

Materials and Methods

Study design

This research is a descriptive study addressing data stratified by the percentage of MMA fighters in their respective combat specializations (primary and secondary as below), grouped into striking, grappling, and mixed categories from in UFC® combats; the present documentary research guaranteed confidentiality and anonymity by replacing the athletes' I.D. There are no ethical problems in investigating MMA public event data, as disposed of by prior protocols [Dos Santos *et al.* 2019]. The study compared the three categories in two moments that consider UFC® performance: when entering (up to 3 months); when entering (after 6 months of entry)

Table 1. Sample characterization of fighters specialized in striking, grappling, and mixed combat in the Ultimate Fighting Championship®

Variables	Primary Moment (±SD)			Secondary Moment (±SD)	
	Striking (n=159)	Grappling (n=201)	Mixed (n=24)	Striking (n=124)	Grappling (n=208)
Age (years)	32.16±4.74	33.80±4.70	30.29±3.71	32.97±4.60	32.68±4.73
Weight (kg)	73.46±17.80	73.60±16.90	72.80±15.94	74.63±18.55	72.81±16.98
Height (m)	1.77±0.10	1.80±0.10	1.78±0.10	1.76±0.09	1.76±0.09
BMI (kg/m^2)	23.08±3.47	23.29±3.31	24.69±4.68	23.52±3.81	23.00±3.24
Wingspan (Ft)	1.81±0.12	1.80±0.11	1.84±0.14	1.82±0.12	1.81±0.12
Leg reach (Ft)	0.91±0.36	0.86±0.37	0.91±0.30	0.92±0.29	0.93±0.33

Legend: Data were described on mean () and standard deviation (±SD).

Note: BMI – Body Mass Index

[Fernandes *et al.* 2018]. The primary and secondary moments were divided and classified according to their respective operational actions.

Sample characterization

Our study performed the sample calculation for a reliable estimate of the finite population mean (μ) [Miarka *et al.* 2015], with an error margin of 10% and a confidence level of 90%. Therefore, the calculations indicated that the minimum sample size would be 384 fighters - the present study's final sample number. The official UFC® website of top-ranked athletes makes available the data, and our study collected this information between 2014 to 2019. After that, grappling, striking, and mixed actions were classified according to these respective groups, but with two paired moments (i.e., primary and secondary) [Dal Bello *et al.* 2019; Miarka *et al.* 2019; Miarka *et al.* 2017a; Miarka *et al.* 2017b]. The following were in the Primary moment (n=384, up to 3 months): Striking category (n=159; 41.4%); Grappling category (n=201; 52.3%) and Mixed category (n=24; 6.3%), while the following were found to be in the Secondary moment (n=384, after 6 months of entry): Striking category (n=124; 32.3%); Grappling category (n=208; 54.2%) and Mixed category (n=52; 13.5%). The sample was characterized by presenting the variables of age, weight, height, body mass index (BMI), wingspan, and leg reach divided by categories and moments according to Table 1.

The following were applied as inclusion criteria: professional UFC® events; athletes, ranked between 2014 and 2019 with more than six years of practice experience. The following were applied as exclusion criteria: athletes not ranked between 2014 to 2019; athletes who did not participate in UFC® events. All participants had previous experience with official MMA events (range level: national-international), following the UFC® rules and procedures. No modifications were made in participants' training, nutritional, or hydration status, following preceding protocols [Antonietto *et al.* 2019]. There are no ethical problems in investigating public events data, as disposed of by prior protocols [Fernandes *et al.* 2018; Dos Santos *et al.* 2019]. The present research was previously approved by the local Ethics and Research Committee, following the W.M.A. Declaration of Helsinki.

Collection and registration procedures

Data collection was performed from September to December 2019 on the official UFC® website [https://www.ufc.com.br/rankings]. The collected variables were submitted to a process of inter and intra-comparison validation to assess the internal consistency and the reproducibility method [Ortega-Toro *et al.* 2019; Tornello *et*

Table 2. Descriptive data on the percentage of technical actions in MMA fighters, separated by category and moment in the Ultimate Fighting Championship*.

Variables	Primary Moment Q2(Q1;Q3)			Secondary Moment Q2(Q1;Q3)	
	Striking (n=159)	Grappling (n=201)	Mixed (n=24)	Striking (n=124)	Grappling (n=208)
Striking techniques	46(41;52)	44(39;49)	41(32;51)**	46(41;51)	45(40;51)
Grappling tecniques	38(27;53)	39(30;50)	33(30;46)	40(27;53)	40(30;52)
Combat Time	708 (542;797)	682 (550;754)	594 (476;744)	670 (542;746)	712 (549;785)
Ending Round	3(2;3)	3(2;3)	3(2;3)	3(2;3)	3(2;3)

Legend: Significant difference between groups *(p>0.05). **(p>0.001). Data described in: Q2 - 2nd quartile - 50% (Q1 -1st quartile - 25%; Q3 -3rd quartile - 75%).

Table 3. Descriptive data of the percentage of the final result of the combat, separated by category and Ultimate Fighting Championship * moments

Variables	Primary Moment Q2(Q1;Q3)			Secondary Moment Q2(Q1;Q3)	
	Striking (n=159)	Grappling (n=201)	Mixed (n=24)	Striking (n=124)	Grappling (n=208)
Combat Result					
Victory	17(13;22)	18(13;22)	16(13;19)	16(12;21)	16(12;20)
Defeat	0(0;4)	0(0;4)	0(0;4)	0(0;1)	5(1;10)**
Draw	3(0;6)	4(1;7)	1(0;3)**	4(1;7)	0,5(0;2)**
Combat Outcome Methods					
Knockout	8(4;11)*	5(3;8)	5(4;8)	7(4;10)**	6(3;10)
Submission	3(1;5)**	5(3;8)	5(2;7)	3(1;6)**	4(2;7)
Referees Decision	5(3;8)	5(3;8)	4(2;8)	5(2;8)	6(3;9)

Note: Other methods related to the result of the combat did not obtain numerical expression, such as disqualification and withdrawal. Legend: Significant difference between groups *(p>0.05). **(p>0.001). Data described in: Q2 - 2nd quartile - 50% (Q1 - 1st quartile - 25%; Q3 - 3rd quartile - 75%).

Table 4. Descriptive data on the percentage of striking techniques in combat situations and the direction of attacks, separated by categories and moments in the Ultimate Fighting Championship*.

Variables	Primary Moment Q2(Q1;Q3)			Secondary Moment Q2(Q1;Q3)	
	Striking (n=201)	Grappling (n=24)	Mixed (n=159)	Striking (n=208)	Grappling (n=52)
Combat Situation					
Distance	216(116;388)	198(92;312)	98(34;197)**	219(114;386)	202(99;354)
Clinch	50(24;91)	50(27;93)	14(7;38)**	50(29;102)	53(28;87)
Ground	44(19;91)	65(22;119)	16(2;38)**	52(22;101)	62(24;109)
Attack Orientation					
Head	205(116;332)	196(94;319)	107(38;180)**	216(116;375)	188(105;311)
Body	74(35;116)	71(35;110)	26(11;59)**	79(38;127)	72(37;107)
Leg	50(25;98)	46(22;76)	10(4;49)**	53(26;93)	48(22;86)
Round Time	11(9;12)	11(9;12)	9(7;12)	11(9;12)	11(9;13)

*Legend: Significant differences by groups **(p≤0.001). Data described in: Q2 - 2nd quartile - 50% (Q1 - 1st quartile - 25%; Q3 - 3rd quartile - 75%).*

al. 2013], and performed by peers to minimize bias in the search process [Magua *et al.* 2017]. The terms and conditions of use applicable to the official UFC® website [https://www.ufc.com.br/terms] were followed and all agreement criteria were met.

The data analyzed show striking, grappling, and mixed techniques shown in percentage. Combat time and round time variables are presented in seconds. The following T-T actions can be analyzed by situation and orientation of the attacks between the beginning and the end of the combat and according to the methodology described in a previously published study [Del Vecchio *et al.* 2015].

The present study used a performance analysis based on T-T actions involving a diverse set of skills: techniques (striking and grappling), types of combat results (victory, defeat, draw, knockout, submission, referee decision), combat situations (distance, clinching and ground) and attack guidelines (head, body, and leg) [Kirk *et al.* 2015; James *et al.* 2017; Miarka *et al.* 2016; Miarka *et al.* 2017a; Miarka *et al.* 2019].

Statistical analysis

The Kolmogorov-Smirnov test (K-S) was used to determine the normal distribution of the data. The null hypothesis was rejected, with p≤0.05 for all variables in the present study. One-way ANOVA and Bonferroni's post hoc were used for descriptive statistics. Descriptive analyses were performed and demonstrated in mean (X) and standard deviation (±SD) for parametric variables. At the same time, the Kruskal-Wallis test (X2) and Dunn's post-hoc Q1 were used for the non-parametric variables, described as (1st quartile - 25%), Q2 (2nd quartile - 50%), and Q3 (3rd quartile - 75%). The groups were distributed according to their primary and secondary modality, striking, grappling, and mixed moments. Cohen's (d) test was used to calculate the effect size. This analysis consists of a small effect (ES<0.30), medium effect (ES<0.70), and a large effect (ES<0.80) [Murphy *et al.* 2014]. The significance level was set at p<0.05 for all analyzes. Data were analyzed using the Statistical Package for the Social Sciences v. 22.0 program (SPSS).

Results

Regarding the primary moment, the comparison between the groups indicated a significant difference in draws (X2=11.09; df=2; p=0.011; d=0.028), KO (X2=14.95; df=2 p=0.002; d=0.038) and submissions (X2=34.1; df=2; p≤0.001; d=0.088), while the secondary moment showed a difference in victories (X2=11.84; df=2; p=0.008; d=0.030), defeats (X2=78.04; df=2; p≤0.001; d=0.20), draws (X2=22.80; df=2; p≤0.001; d=0.059), KO (X2=14.95; df=2; p=0.002; d=0.038), submissions (X2=34.1; df=2; p≤0.001; d=0.088) and decisions by referee (X2=10.54; df=2; p=0.014; d=0.027). In the primary moment, the Mixed group had the lowest number of draws (p ≤ 0.001 for all comparisons), and in the secondary moment, the Mixed group obtained the highest number of defeats, the lowest number of draws, and the lowest number of decisions by referees (p≤0.001 for all comparisons). The Striking group reached a higher percentage of KO and pointed to a lower number of finishes in the primary moment (p≤0.001 for all comparisons), while in the secondary moment, the Striking group obtained a higher number of KO and obtained a lower number of submissions (p≤0.001 for comparisons). The Grappling group had a larger number of victories in the second moment (p=0.008 and = 0.012). No difference was observed for the number of victories, defeats, and referees' decisions (p>0.05 in all comparisons) in the primary moment, whereas in the second moment, there was a difference for KO and submissions (p≤0.001 for comparisons).

Table 4 presents the descriptive data for the combat situations through the striking techniques in distance,

clinch, and ground, and the attacks targeted to the head, body, leg, and total round time.

Regarding the primary moment, the comparison between the groups showed a significant difference in the quantity of striking techniques in a distance combat situation (X2=17.27; df=2; p≤0.001; d=0.044), clinching (X2=24.53; df=2; p≤0.001; d=0.063), ground (X2=25.81; df=2; p≤0.001; d=0.067), attacks directed at the head (X2=17.73); df=2; p≤0.001; d=0.046); body (X2=30.1; df=2; p≤0.001; d=0.078); and legs (X2=24.2; df=2; p≤0.001; d=0.063). The secondary moment indicated a difference in the amount of striking techniques in a distance combat situation (X2=15.89; df=2; p≤0.001; d=0.041), clinching (X2=22.51; df=2; p≤0.001; d=0.058) and ground (X2=21.37; df=2; p≤0.001; d=0.055), orientation of attacks directed to the head (X2=16.16; df=2; p≤0.001; d=0.042), body (X2=26.47; df=2; p≤0.001; d=0.068) and legs (X2=25.29; df=2; p≤0.001; d=0.065). The mixed group presented a lower number of striking techniques in clinching, grounding, attacks directed at the head, body, and legs in the primary moment and in the secondary moment (p≤0.001 for all comparisons).

Discussion

The study described and analyzed the T-T actions of fighters who were already specialized in grappling, striking, and mixed combat when joining UFC®. The main results showed differences between the categories concerning the primary moment, using striking techniques to differentiate the groups. At the secondary moment, the analysis indicated differences in the percentage of using striking and grappling techniques—the Mixed group presented with a lower rate of striking techniques such as grappling between categories and moments. The analysis of these indicators of the use of striking and grappling techniques, especially discovering the lowest percentage directed at the mixed group, revealed innovative scientific research scenarios. There are no studies to ascertain athletes who already primarily practiced a mixed sport and continued doing it.

The present result showed that when entering the UFC®, the fighters had experience in combat sports in the primary moment in mixed categories of 6.3%, striking of 41.4%, and grappling of 52.3%. MMA athletes trained in the primary modality of combat sports but incorporated aspects of other categories throughout their careers, expanding their T-T skills. When remaining in the UFC® and incorporating elements from different classes, they presented a 3.63% increase in the grappling category. The striking type decreased by 21.98%, and the mixed class increased by 114.28%. Finally, it is necessary that the athlete has technical skills and develops skills in several different areas based on the choice of striking, grappling, and submission tasks in seeking the main aim of finishing the fight [James *et al.* 2016; Lonergan *et al.* 2018]. It is visible that there is an increase in mixed categories, consequently a simultaneous rise in techniques exercised by fighters who need to specialize effectively in specific T-T actions. The most significant actions currently used in competitions are in constant development, so the need to direct training mainly to mixed groups according to the fight's competitive demand.

The investigation revealed that the highest percentage of actions used between the three groups were striking techniques in both the primary and secondary moments, demonstrating that the initial fighters in the modality maintain a significant number of attacks in their MMA career. We understand that the athlete's experience is a potential success mediator and can help combat actions to organize T-T actions to quickly adapt to spatiotemporal changes during the athlete's career. This statement corroborates with the study of Dos Santos *et al.* [2019], who investigated the probabilities of performance in the rounds of MMA, and indicated strikes to the body, head, total and unique, while strike attempts to the body and head were the variables that increased the likelihood of association over the years [Dos Santos *et al.* 2019].

Other significant findings refer to the comparison of the secondary specialty groups; all groups were substantial in grappling techniques. However, it is noted that striking fighters seek to specialize in grappling along with their careers. These maneuvers are explained in the study by Miarka *et al.* [2017a], which describes how the development of the grappling characteristic can improve the performance of a strong skill in MMA.

According to the study, the mixed group showed a lower percentage of technical actions in both the primary and secondary moments, which expands scientific knowledge and directly applies in the MMA scenario for both athletes and the training commission. One realizes the importance of directing mixed fighters to specialize in technical striking and grappling actions, establishing tactical strategies at the exact moment to obtain control of the fight. Bearing in mind the dynamism of MMA sport, the ability to move from one position to another is fundamental.

Due to the relative scarcity of research on the mixed specialty of performance in MMA, little is known about the requirements to maximize the participants' chances of success. A study by James *et al.* [2017] demonstrated that adequate grappling and technique accuracy are the determining factors for winning and losing [James *et al.* 2017]. Another study pointed out the successful falls as a distinguishing factor between winners and losers in boxing matches in MMA [Kirk *et al.* 2015]. The present study can serve as a reference and contribute to coaches to assist in the training of MMA fighters, especially in the mixed category. We believe that striking and grappling techniques or both are effective; their use during

the fight determines which strategy is most appropriate for the combat context, demonstrating what information to use to understand the T-T characteristics of the categories to be inserted into mixed fighter training.

However, a study by Miarka *et al.* [2016] claims that grappling is the primary technique used by MMA athletes. In contrast, blows to the head, distance, and actions to successfully take down the opponent are the main determinants of victory [Miarka *et al.* 2017b]. Kirk [2018] indicated that impressive techniques are responsible for the most critical differences between winners and losers. Pure grappling movements demonstrated decisive factors and differences between winners and losers; the grip associated with striking seems to be as important as the fight alone [Kirk 2018].

In general, the results presented in this study contrast with the evidence observed in previous studies [Kirk *et al.* 2015; Miarka *et al.* 2016, 2017a; James *et al.* 2017; Lonergan *et al.* 2018]. However, none of the previous protocols investigated whether mixed techniques in MMA can be significant. Based on these findings, it is suggested that mixed techniques are responsible for essential differences during combat. Fighters tend to enter MMA with extensive training in a combat sport. No single combat category has been consistently dominant in all situations [Downey 2014]. However, it is necessary to incorporate striking and grappling techniques and know how to use them in different fight moments.

Notably, the T-T actions of grappling and striking are practical if applied at the right time in the fight. However, mixed fighters need a better organization of these actions at opportune moments. For instance, isolated training in specific training plan moments using striking or grappling movements could be interesting for adjusting technical conditions and decision making. However, to improve the pacing strategy, it could be utilized specifically in mixed training, as mixed athletes demonstrated a better pacing strategy than other modalities.

The focus on training specific actions for mixed groups, mainly in the association of predefined procedures, allows fighters to correct when and how to use such technical activities, being essential for mixed fighters to develop technical proficiency and tactical approach to provide self-regulation in the fight.

One of the original aspects of the present study refers to the scarcity of analyzes on athletes of the secondary modality in the literature. The striking group had a higher K.O. percentage in both primary and secondary specializations in the variables analyzed. According to Miarka *et al.* [2018], K.O./Technical Knockout (T.K.O.) is the main result that defines the final round (≈60%), which can also be explained by Dos Santos *et al.* [2019], which suggests that athletes should focus on the moment of standing combat, combined with strike actions. By hitting their heads, fighters are more likely to win, avoiding unsuccessful attempts and body attacks.

In the research results, the striking group had the least number of submissions in both the primary and secondary moments, so an explanation is considered that Striking in MMA is necessary, some distance between combatants, also known as reach, which could be a plausible explanation [Pomerantz 2018] and this variable was not assessed in this research.

The grappling group had the highest number of victories in the secondary specialization. However, it is unknown whether the result is the influence of a second modality used by the fighters. MMA requires actions that require a diverse set of skills, including standing and ground grappling capabilities, because the relationships between those skills represent the main aspects of attack and grappling systems [Coswig *et al.* 2016; Sterkowicz-Przybycien, Fukuda 2016; Dal Bello *et al.* 2019]. Also, the characteristic grappling development can improve the performance of a vital skill in MMA [Miarka *et al.* 2017a]. However, grappling's basic principles are commonly accepted as essential to success in this modality [Dal Bello *et al.* 2019].

The variables analyzed for the mixed group showed a lower percentage of draws in both the primary and secondary specializations. Simultaneously, fewer decisions by referees and more defeats were found in the second combat modality. In the review carried out by this study, one study is observed, indicating that combinations of techniques increase the probability of victory for a participant [Kirk 2018]. However, a mixed category includes both striking and grappling [Lonergan *et al.* 2018]. The present study has a limitation related to mixed category athletes; of the 384 fighters, only 24 are of the primary moment, and 52 are secondary.

The present data corroborate the findings in a study by Miarka *et al.* [2017a], which had significant effects on different variables in the combat phases of the T-T actions standing and on the ground. Regarding the situation of keeping distance, the results indicated a significant impact for all variables in which the means observed in the victories were higher than the losses ($p>0.05$) for the clinching and ground phases ($p\leq0.05$), distance ($p<0.001$), for the striking attacks to the head and strikes to the head, with greater O.D.D. for head strikes (Exp B - 1,114). For the clinching phase, falls, attempted falls, offensive passes ($p<0.05$) showed greater O.D.D. for takedowns from the ground (Exp B - 1,768). Only the attempts were significant ($p=0.004$) [James *et al.* 2017; Dal Bello *et al.* 2019; Dos Santos *et al.* 2019].

Based on the results found, it is clear that the mixed group differed significantly in a more significant number of variables. This result can be explained by the fact that fighters seek to specialize in the complexity of fights in MMA. Simultaneously, those that ended during the 1st or second round had less total time and standing combat, at low intensity, than the fights that ended in the 3rd

round. Regarding these fights, standing combat time at high power was more significant in the last round than the attacks, which ended in the 1st or second round [Miarka *et al.* 2018]. We suggest that mixed fighters, due to their training, specialize in specific striking and/or grappling actions to use in moments that require techniques and tactical strategies specific to one of the different modalities to obtain greater efficiency during the fight.

The results indicate the need for new research on the topic, considering striking, grappling, and ground attack systems. There are still new possibilities for discoveries given several significant variables in the three groups. It should be noted that the methodological procedures adopted in this study, such as the descriptive method associated with quantitative techniques which proved to be adequate for the objectives of the study, showing themselves capable of analyzing the results found.

Little is known about the mixed category, but relevant studies are about the grappling and striking group. However, scientific deepening is necessary to understand the findings of the research. We suggest that the limitation in the number of mixed fighters is a factor to be highlighted in future research. Therefore, it is recommended that MMA fights require good physical training, deepening of T-T, temporality actions, and efficient activities during the bout. These findings can improve training sessions associated with grappling, striking, or mixed movements. Finally, there is a clear need to obtain one or more specializations in addition to the primary. These factors can lead to possible success in MMA.

The practical application of the present study on the T-T actions of fighters specialized in combat sports in the UFC® has to consider relevant points for coaches and athletes, especially when incorporating a new fighting specialty and for mixed athletes.

It points out that the technical actions of striking were more expressive in the primary and secondary moments. We suggest mixed and grappling groups to improve striking techniques, improve tactical action strategies and develop training for short-duration conditioning, high intensity, and resistance to efficiently perform special attacks and use them at the right time fight.

In the secondary moment, grappling's technical actions showed a significant improvement between the groups, mainly concerning the fights' result, presenting a more considerable number of victories for grappling athletes. We guide the need for training aimed at the grappling technique's actions to provide self-regulation of specific demands of the fight in the opponent's control for the striking and mixed groups according to the combat's intensity and moment.

We suggest that coaches plan sessions focusing on the development of positional control, transitional control, rhythm, and frequency of striking and grappling techniques, adapting tactical strategies according to the specific moment of the combat situation, and attack orientation MMA because particular actions in the bout context can lead to more K.O. and or end by submission. The present research can offer information to improve training plans for grappling, striking, and mixed categories on technical and tactical actions. Also, our study indicates the differences between moments, which could improve specific training sessions, according to competitive demands in MMA.

Conclusion

This work pointed out that there are characteristics and technical actions that differentiate athletes who previously practiced striking combat sports, with better pacing strategy but lower attacks to the Mixed group. However, it is essential to consider that the number of actions during the match can directly interfere with the referees' decision. Therefore, MMA athletes who perform mixed training must pay attention to the number of activities and accuracy. In the same way, grappling and striking athletes need to pay attention to precision and not only to the volume of attacks made during combat. Applying this in a practical situation suggests a greater focus on volume during the initial training period, with remote grappling and striking training sessions. In contrast, mixed practices are essential close to the competition contextualized according to possible strategies in effort-pause ratios and the bout's frequency of actions. In turn, specific tactical adjustments are necessary for the athlete to anticipate the opponent's moves.

Acknowledgements

JRF thanks the FAPEMIG - Fundacao de Amparo a Pesquisa do Estado de Minas Gerais, and MAB thanks the Capes - Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior. Both institutions financied in part this study with Master's funding grants for our students.

References

1. Antonietto N.R., Bello F.D., Queiroz A.C.C., Berbert de Carvalho P.H., Brito C.J., Amtmann J., Miarka B. (2019), *Suggestions for Professional Mixed Martial Arts Training With Pacing Strategy and Technical-Tactical Actions by Rounds*, "Journal of Strength and Conditioning Research"; doi: 10.1519/JSC.0000000000003018.
2. Chernozub A., Korobeynikov G., Mytskan B., Korobeinikova L., Cynarski W.J. (2018), *Modelling Mixed Martial Arts Power Training Needs Depending on the Predominance of the Strike or Wrestling Fighting Style*, "Ido Movement for Culture. Journal of Martial Arts Anthropology", vol. 18, pp. 28–36; doi: 10.14589/ido.18.3.5.

3. Coswig V.S., Fukuda D.H., de Paula Ramos S., Del Vecchio F.B. (2016), *Biochemical differences between official and simulated mixed martial arts (MMA) matches*, "Asian Journal of Sports Medicine", vol. 7, no. 2; doi: 10.5812/asjsm.30950.
4. Coswig V.S., Miarka B., Pires D.A., Da Silva L.M., Bartel C., Del Vecchio F.B. (2019), *Weight Regain, but not Weight Loss, Is Related to Competitive Success in Real-Life Mixed Martial Arts Competition*, "International Journal of Sport Nutrition and Exercise Metabolism", vol. 29, pp. 1–8; doi: 10/gf48t4.
5. Dal Bello F., Brito C.J., Amtmann J., Miarka B. (2019), *Ending MMA combat, specific grappling techniques according to the type of the outcome*, "Journal of Human Kinetics", vol. 67, pp. 271–280; doi: 10.2478/hukin-2018-0081.
6. Del Vecchio F.B., da Silva K.C., Miarka B. (2015), *Time-motion analysis in Mixed Martial Arts (MMA) combats: Comparisons between genders*, "Connections: Physical Education, Sport and Health", vol. 13, pp. 48–64; https://doi.org/10.20396/conex.v13i3.8640870.
7. Dos Santos D.A., Miarka B., Dal Bello F., Queiroz A.C.C., de Carvalho P.H.B., Brito C.J. (2019), *10 Years on Time–Motion and Motor Actions of Paired Mixed Martial Arts Athletes,* "International Journal of Sports Physiology & Performance", vol. 14; doi:10/gf48t3.
8. Downey G. (2014), *'As Real As It Gets!' Producing hyperviolence in mixed martial arts,* "JOMEC Journal"; doi:10.18573/j.2014.10268.
9. Drury B.T., Lehman T.P., Rayan G. (2017), *Hand and wrist injuries in boxing and the martial arts*, "Hand Clinics", vol. 33, pp. 97–106; doi: 10.1016/j.hcl.2016.08.004.
10. Fernandes J.R., Dal Bello F., Brito M.A., De Carvalho P.H., Queiroz A.C.C., Brito C.J., Miarka B. (2018), *Effect of rule changes on technical-tactical actions correlated with injury incidence in Professional Mixed Martial Arts*, "Journal of Physical Education and Sport", vol. 18, no. 3, pp. 1713-1721; doi: 10.7752/jpes.2018.03250.
11. James L.P., Haff G.G., Kelly V.G., Beckman E.M. (2016), *Towards a determination of the physiological characteristics distinguishing successful mixed martial arts athletes: a systematic review of combat sport literature*, "Sports Medicine", vol. 46, pp. 1525–1551; doi: 10/f9cfg2.
12. James L.P., Haff G.G., Kelly V.G., Beckman E.M. (2018), *Physiological determinants of mixed martial arts performance and method of competition outcome*, "International Journal of Sports Science & Coaching", vol. 13, pp. 978–984; doi: 10/gf48t6.
13. James L.P., Robertson S., Haff G.G., Beckman E.M., Kelly V.G. (2017), *Identifying the performance characteristics of a winning outcome in elite mixed martial arts competition,* "Journal of Science and Medicine in Sport", vol. 20, pp. 296–301; doi: 10/gft7c6.
14. Kirk C. (2018), *Does anthropometry influence technical factors in competitive mixed martial arts*, "Human Movement", vol. 19, pp. 46–59; doi: 10.5114/hm.2018.74059.
15. Kirk C., Hurst H.T., Atkins S. (2015), *Measuring the workload of mixed martial arts using accelerometry, time motion analysis and lactate*, "International Journal of Performance Analysis in Sport", vol. 15, pp. 359–370; doi:10/gft7cz.
16. Lonergan B.M., Tallent J., Lazarczuk S. (2018), *Needs analysis of mixed martial arts,* "Journal of Australian Strength and Conditioning", vol. 26, no. 5; Retrived from https://research.stmarys.ac.uk/id/eprint/2070.
17. Magua W., Zhu X., Bhattacharya A., Filut A., Potvien A., Leatherberry R., Kaatz A. (2017), *Are female applicants disadvantaged in National Institutes of Health peer review? Combining algorithmic text mining and qualitative methods to detect evaluative differences in R01 reviewers' critiques*, "Journal of Women's Health", vol. 26, no. 5, pp. 560-570; doi: 10.1089/jwh.2016.6021.
18. Miarka B., Brito C.J., Amtmann J. (2017a), *Performance probabilities and outcome effects in technical–tactical factors with bout phase changes of mixed martial arts*, "International Journal of Performance Analysis in Sport", vol. 17, pp. 510–520; doi:10/gfscgz.
19. Miarka B., Brito C.J., Dal Bello F., Amtmann J. (2017b), *Motor actions and spatiotemporal changes by weight divisions of mixed martial arts: Applications for training*, "Human Movement Science", vol. 55, pp. 73–80; doi: 10.1016/j.humov.2017.07.009.
20. Miarka B., Brito C.J., Moreira D.G., Amtmann J. (2018), *Differences by Ending Rounds and Other Rounds in Time-Motion Analysis of Mixed Martial Arts: Implications for Assessment and Training*, "The Journal of Strength & Conditioning Research", vol. 32, pp. 534–544; doi: 10.1519/JSC.0000000000001804.
21. Miarka B., Coswig V.S., Amtmann J. (2019), *Long MMA fights technical-tactical analysis of mixed martial arts: implications for assessment and training*, "International Journal of Performance Analysis in Sport", pp. 1–14; doi:10/gf5p7n.
22. Miarka B., Coswig V.S., Vecchio F.B., Brito C.J., Amtmann J. (2015), *Comparisons of time-motion analysis of mixed martial arts rounds by weight divisions*, "International Journal of Performance Analysis in Sport", vol. 15, pp. 1189–1201; doi: 10/gft7cg.
23. Miarka B., Vecchio F.B.D., Camey S., Amtmann J. A. (2016), *Comparisons: Technical-Tactical and Time-Motion Analysis of Mixed Martial Arts by Outcomes*, "Journal of Strength and Conditioning Research", vol. 30, pp. 1975–1984; doi:10/gf48tx.
24. Murphy K.R., Myors B., Wolach A. (2014), *Statistical power analysis: A simple and general model for traditional and modern hypothesis tests*, Routledge; https://doi.org/10.4324/9781315773155.
25. Ortega-Toro E., Garcia-Angulo A., Gimenez-Egido J.M., Garcia-Angulo F.J., Palao J.M. (2019), *Design, validation, and reliability of an observation instrument for technical and tactical actions of the offense phase in soccer*, "Frontiers in Psychology", vol. 10, pp. 22; doi: 10.3389/fpsyg.2019.00022.
26. Pomerantz M.L. (2018), *Hand and Wrist Injuries in Mixed Martial Arts*, in: "Hand and Wrist Injuries in Combat Sports", Springer Cham, pp. 63–76; doi: 10.1007/978-3-319-52902-8_7.
27. Robbins T., Zemanek J. (2017), *UFC pay-per-view buys and the value of the celebrity fighter*, "Innov Mark", vol. 13, pp. 35-46; doi: 10.21511/im.13(4).2017.04.

28. Staack M. (2019), *Introduction: MMA as 'Fighting As Real As It Gets'* [in:] J.B. Metzler [ed.], *Fighting As Real As It Gets*, Stuttgart, pp. 1-7; doi: 10.1007/978-3-476-04991-9_1.
29. Sterkowicz-Przybycien K., Fukuda D.H. (2016), *Sex differences and the effects of modified combat regulations on endurance capacity in judo athletes: A meta-analytic approach*, "Journal of Human Kinetics", vol. 51, pp. 113–120; doi: 10.1515/hukin-2015-0175.
30. Tornello F., Capranica L., Chiodo S., Minganti C., Tessitore A. (2013), *Time-motion analysis of youth Olympic Taekwondo combats*, "The Journal of Strength & Conditioning Research", vol. 27, no. 1, pp. 223-228; doi: 10.1519/JSC .0b013e3182541edd.

Działania techniczno-taktyczne zawodników specjalizujących się w uderzeniach, grapplingu i walkach mieszanych w Ultimate Fighting Championship®

Słowa kluczowe: sztuki walki, grappling, uderzenia, techniczno-taktyczne, sporty walki

Streszczenie

Tło. Celem pracy był opis i analiza działań techniczno-taktycznych stosowanych przez zawodników, którzy mieli już doświadczenie w uderzeniach, grapplingu i mieszanych sportach walki w momencie dołączenia do Ultimate Fighting Championship® (UFC®).

Metody. Obecne badania analizowały wyniki 384 sportowców, sklasyfikowanych jako grapplerzy, uderzający lub zawodnicy mieszanych sztuk walki podczas walk w początkowym okresie UFC® (<3 miesiące) i w dalszym okresie (>6 miesięcy UFC®). Analizowane dane porównywały techniki uderzania, grapplingowe i mieszane, $p<0,05$.

Wyniki. Stwierdzono różnice pomiędzy grupami w zakresie procentowego udziału akcji, gdyż zawodnicy startujący w mieszanych sportach walki stosowali mniejszy procent akcji z uderzaniami w modalności pierwotnej [41 (32,3; 51,5); $p\leq0,001$] i wtórnej [40 (35,3; 46,0); $p\leq0,001$], technik grapplingowych [32,0 (17,5; 41,5); $p\leq0,001$] oraz wysokich wyników remisowych [1,0 (0,0; 3,0); $p\leq0,001$]. Jeśli chodzi o wyniki to napastnicy kończyli walkę przez nokaut/techniczny nokaut [8,0 (4,0; 11,0); $p\leq0,001$]. Dla modalności drugorzędnej były to: przegrana [5,0 (1,0; 10,0); $p\leq0,001$], remis [0,5 (0,0; 2,0); $p\leq0,001$] i decyzja sędziowska [4,0 (3,0; 7,0); $p\leq0.001$] przeważały u zawodników mieszanych; nokaut/techniczny nokaut [7,0 (4,0; 10,0); $p\leq0,001$] i poddanie [3,0 (1,0; 6,0); $p\leq0,001$] przeważały u napastników.

Wnioski. Prezentowane wyniki wykazały, że specyficzne działania techniczne różnicują zawodników uprawiających wcześniej sporty walki wręcz i grapplingowe. Szczególną uwagę zwrócono na sportowców wywodzących się z dyscyplin mieszanych, którzy mieli lepszą strategię ustanawiania tempa, ale mniejszą liczbę ataków.