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## REVIEW ARTICLE

# Theoretical Basis of Technical-tactical Behavior and its Application in Ultimate Full Contact Training

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### Abstract:

#### Background:

Technical-tactical training has been shown to be relevant to performance in a competition. In this regard, several studies have analysed the efficiency of technical-tactical dynamics in combat sports. However, these researchers have mainly focused on technical efficiency, and therefore more research is needed regarding tactical efficiency. Furthermore, to the best of our knowledge, there are no published experiential studies on Ultimate Full Contact.

#### Objective:

This brief review will analyse the theoretical basis of technical-tactical behaviour for training application in Ultimate Full Contact, characterising the modality under cognitive and dynamic-ecological approaches. This knowledge can be transferred and applied to similar modalities, such as Pankration, Free Fight, Shooto, and Mixed Martial Arts (MMA).

#### Conclusion:

The theoretical technical-tactical knowledge created through competition is essential because it is the only way that improvement in the training process can occur. Ultimate Full Contact is characterised as a combat sport of special complexity and intermittent intensity, where the technical-tactical factors are decisive for the performance while the physical component can be a conditioning factor. A careful regulation between technical-tactical training load and physiological load is essential to obtain adjustable adaptations. Both cognitive and dynamic-ecological approaches should be considered based on the respective training models.

**Keywords:** Combat sports, Ultimate full contact, Pankration, mma mixed martial arts, Free-fight, Technical-tactical, Cognitive and dynamic-ecological approaches, Training methods, Styles, Combat distances.

### Article History

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## 1. PROBLEM DEFINITION

Ultimate Full Contact was established in 1988 by the World Ultimate Full Contact (WUFC). It is a combat art with a special complexity based on Pankration and it has been significantly influenced by Taekwondo, Boxing, Muay Thai, American Full Contact, Kickboxing (*i.e.*, striking combat sports) and Submission Grappling (*i.e.*, skills from sambo, wrestling and jiu jitsu, among other close fights) [1 - 3]. The striking combat sports mentioned are developed over three or more rounds of two or three minutes each, spaced by one-

minute breaks [3 - 7] and the submission grappling combat sport are developed in one round of six, eight, ten or twenty minutes [8]. While the Ultimate Full Contact is developed over one round of ten minutes (1 × 10 min), where techniques adapted from all mentioned combat styles are presented [9]. This results in a higher variability of technical-tactical dynamics, implying a greater variety of efforts [10 - 14]. It resembles Mixed Martial Arts (MMA) (*i.e.*, modality developed from *vale tudo*), which is also composed of striking and submission grappling actions, with specialised techniques from traditional combat styles [15 - 18]. Like other hybrid full contact combat sports (*e.g.*, MMA), Ultimate Full Contact is characterised as an intermittent sport in terms of technical-tactical and energetic resources, which combines stand-up fighting with ground fighting [1 - 3, 9, 19]. The fights are

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developed under the context of high variability, unpredictability and tenacity with high volitional effort due power strikes and takedowns of great amplitude, where the knockout (KO) may happen at any moment [1, 3]. In this context, in addition to performance constraints (*i.e.*, physical, psychological, socio-affective), technical and tactical capacities are determinants and are decisive in performance [1, 3]. In fact, according to the literature, in complex sports such as combat sports or collective sports, it is only through technical-tactical training that all other skills are developed [20]. Furthermore, a previous research with fighters and coaches from different martial arts and combat sports (*i.e.*, full contact, taekwondo, boxing, ultimate full contact, pankration, free-fight, MMA, wrestling, judo, Muay Thai, karate, Jiu jitsu) has highlighted that technical-tactical skills and psychological capacities are the most important dimensions for performance [1]. In addition, it is known that the technical-tactical performance in competition is linked to contextualised training practice [21 - 24]. Therefore, the theoretical knowledge that is acquired through practice and then scientifically analysed is a determinant means to develop the coach's skills and the fighter's performance, improving the scientific-training intervention and the fighter's development [1]. Observation of the fighter's dynamics in the competition is recommended because it allows us to obtain representative knowledge for contextualised practices [15, 16, 25 - 33]. However, the literature describes that technical-tactical analysis determines references for contextualised training programs that are adapted to the requirements and regulations of a specific combat sport [4, 34, 35]. In fact, the fighters have been shown to have different profiles of perceptual-motor performance in distinct combat sports [36], even in the same modality, while the regulations modifications imply distinct technical-tactical dynamics [37]. In this reasoning, it is understandable that (for example) trying to make an armlock in a context where only submission grappling is allowed is very different from a context where it is also allowed to strike; or punching when the rules allow only punching is very different if the rules also allow kicking or grappling. In addition, most of the current technical-tactical studies in combat sports result from modalities of different characteristics, whose competitions rules allow a restricted number of skills when compared to Ultimate Full Contact, such as in Olympic taekwondo WT (World Taekwondo) where essentially leg techniques are used; in boxing where only punches are allowed; in kickboxing, karate, and taekwondo ITF (International Taekwondo Federation) where only punches and kicks techniques are authorised; or in wrestling, judo, and Jiu jitsu, where only submission grappling skills are allowed. Consequently, the preparation for different competitive rules requires an objective and specific assessment [38 - 40].

Although review concerning to technical-tactical dynamics in the Ultimate Full Contact is necessary, through a previous research it was understood that experiential studies are not published. Consequently, this review adopted an inclusion criteria that considers studies carried out in similar modalities (*i.e.*, hybrid full contact combat sports) or in other full contact combat sports studies with great focus on the present investigation. The present review highlights the technical-

tactical performances in hybrid combat sports. It is also our intention to know more about cognitive and dynamic-ecological approaches that are associated with combat sports. To search for relevant publications, the main databases were used (*e.g.*, Web of Science, Scopus, and PubMed). Articles published in all years and in English, Spanish or Portuguese were considered. Primary keywords were used to search ("combat sports" or "martial arts") with a second keyword ("ultimate full contact", "pankration", "free-fight", "mma mixed martial arts", "shooto", *vale tudo*) and a third keyword ("technical-tactical", "cognitive", "dynamic-ecological", "skills", "fighting outcome", "distances", "offensive", "defensive", "counteroffensive", "attack", "counter-attack", "styles"). All articles without a focus on the investigation were excluded. In total, 43 articles were considered to be relevant. However, only 16 articles specifically analyse technical-tactical dynamics in hybrid combat sports, especially in MMA.

## 2. SUMMARY OF PREVIOUS RESEARCH

Previous investigations that analysed the technical-tactical performance help to understand the success of the best fighters [41, 42] because the development of technical and tactical capabilities maximises success in competition [43]. However, the physiologic approach can be a conditioning factor for technical-tactical functionality, especially regarding the variation in the intensity of fights [19, 44, 45]. It is known that striking is more associated with high-intensity regime with an alactate or alactic power system, while in contrast submission grappling is more associated with low-intensity regimes with glycolytic power supply system [44]. Therefore, the necessity to regulate the load of technical-tactical training with the physiological load to obtain adjustable adaptations, combining and articulating single techniques with combinations techniques becomes clear. This is a set of varied and differentiated skills that must remain interrelated as one of the basic conditions in combat [46], with the aim to dominate the opponent through offensive, counteroffensive and defensive actions, searching for the fight outcome by knockout KO, technical knockout TKO, submission or decision [1, 3, 9]. The analysis of technical-tactical actions can help us to understand their different effect on the outcomes, and this way regulate their application through the fights [9, 47 - 49]. In addition, the fight outcomes are related with contextualised practices [49]. Thus, the fight outcome by KO/TKO and submission are more related with striking and grappling actions during ground fighting, while outcomes by decision are more related to stand-up striking [49]. In other studies analysing only grappling style in combat, it is reported that the fight outcomes by KO/TKO, submissions, or score decisions (*i.e.*, unanimous and split) demonstrated technical-tactical pattern. In particular, grappling showed lower frequency attempts with KO/TKO, ground grappling showed higher frequency attempts related to submission outcomes, while stand grappling showed higher frequency attempts related to score decisions [43]. This seems to indicate that different styles are adopted by the fighters and that this may have an influence on the outcome of the fight.

However, successful motor actions require accurate motor control to promote fast adaptations to spatiotemporal variations, and to maintain distances and control over the

opponent with anticipated and adjusted attacks with increased frequency [15, 50]. In fact, the winners showed a higher frequency of strikes, submission, and positional improvements over the losers, as well more self-regulation actions through the rounds, with a significant increase of submission and strangulation attempts at the last round, which gives them high control over the losers [32]. In this field, the striking combinations should be used at a distance. During the clinch, the attacks must be combined with takedowns. In particular, if the fighter is at a disadvantage in the stand-up fighting to his opponent, then he must keep in ground fighting, attempting to end the fight by submission techniques, preferably by choke skills [16]. At a distance, the fighters use free movements/actions without grips, where the skills are characterised by full contact strikes (*i.e.*, kicking, punching, knee and elbow striking) [19, 42 - 51]. In fact, there is a high technical variability, where strikes must be powerful and precise without being exposed to the opponent [16]. At clinch and ground combat, the fighters use submission grappling skills (*i.e.*, grips, takedowns, chokes and joint locks) [51], and ground striking (*i.e.*, ground and pound) [1, 52]. The decision-making by stand-up fighting or ground fighting is a tactical characteristic that depends on the fighter or the context [42, 48, 53]. This consists of an interaction individual-context, which refers to the interrelation between the fighter and the environment, to act in accordance with the opportunities (*i.e.*, affordances) [54]. These opportunities result from the interaction of both fighters as a dynamic-ecological approach. The fighters perceive the opportunities to attack or defend into one interpersonal synergy, and success depends on the ability of their actions to take advantage of the context instability or stability [55]. However, a review by the same author [55], reported that it is the expert fighters who can accurately perceive the limits of action [55]. In addition, the perceptual-cognitive expertise to quickly perceive, interpret and act in advance (*i.e.*, anticipation) to the opponent's actions is a fundamental skill in combat sports [56]. This facility to capture information is more likely to be found in expert fighters [56]. In fact, a general superiority of perceptual-cognitive skills is demonstrated by the expert fighters [57]. This is in line with the cognitive tactical reasoning, where the experience obtained through repeated practice is a fundamental factor to improve the fighter's perception, accurate technique, and decision-making [58, 59]. Systematic repetition automates the actions, works the memory, and increases the capacity of perception and discernment for correct decision-making and precise actions [58]. In this sense, the technical development is based on the evolution of coordination capacity, which requires a pedagogical progression in coordinative complexity as a recommended method for its efficiency [1, 60]. In fact, the hybrid combat sports, such as Ultimate Full Contact, are characterised by a special complexity and they require a high degree of cognitive processing under volitional effort to make appropriate decisions from numerous possible resources, and to define strategies and distances in search of opportunities to attack and counterattack with precision and power [1]. This appropriate decision-making requires a perceptual-cognitive expertise to enable the fighters to perceive and act accordingly (*i.e.*, perception-action), considering the fighting distance, attack progression, and the opponent's reactions [56].

## CONCLUSION AND TRAINING SUGGESTIONS

Technical-tactical studies in specific hybrid combat sports are scarce or even nonexistent (*e.g.*, Ultimate Full Contact, Pankration, Free Fight, Shooto, *Vale Tudo*, and MMA), and the few that exist were developed in MMA. However, tactical abilities such as fighting distances, fighting styles and the development of offensive, counteroffensive and defensive dynamics require further investigation given their importance for performance during the fight. In this review, the technical-tactical theoretical basis of Ultimate Full Contact has been identified as a hybrid combat sport of special complexity and intermittent structure in technical-tactical and physiological aspects, combining single actions with combination actions of different intensities. These are a set of variety technical-tactical actions that aim to overcome the opponent.

The fights take place in contexts of high unpredictability, variability, and tenacity, with stand-up fighting and/or ground fighting, where fighters are characterised by stand-up-strikers, ground strikers and submission grapplers, according to their techniques and tactical behaviours. A stand-up fighter is one who keeps the distance (long or short) using extent full contact strikes (*i.e.*, kicks and straight punches—jab, cross and back fist) or short strikes (*i.e.*, knees, elbows and short punches—hooks and uppercuts); the ground strikers and submission grapplers are those who keep the close distance with clinch and grips, aiming to takedown the opponent and end the fight using chokes, joint locks, or ground and pound, respectively.

To be successful in combat, the ultimate full contact fighters need to develop a high and varied technical-tactical repertoire and qualities in their actions, such as anticipation, quick perception and interpretation, spatiotemporal-synchronisation and adaptation, adequate decision-making, automation, context adaptability, timing, seizing opportunities, unpredictability, distance measurement, balance, displacements, efficiency, precision and power.

We suggest that the training process, through both stand-up and ground fighting skills, should be developed based on the cognitive and dynamic-ecological models because this will ensure that the combat actions are safe, correct, adequate, precise and at the same time spontaneous, representative and creative (*e.g.*, intercalate analytical and integrated training methods through systematics technical-tactical repetitions one-to-one and formal or limited and fractional sparring). According to the literature, in complex sports such as combat sports or collective sports, technical-tactical training enables all other skills to be developed (*i.e.*, physical, psychological and socio-affective). Consequently, the load of technical-tactical training should be regulated with the physiological load to obtain adjustable adaptations (*e.g.*, practice technical exercises under interval or intermittent training).

It is also important to highlight that the ultimate full contact training is a complex process, transversal coach-athlete, that is guided by scientific principles (*i.e.*, methodological, biological, and pedagogical). Thus, the theoretical basis of technical-tactical behaviour is essential and useful information for coaches who wish to optimize their methodologies,

intervention capacity, and who wish to give feedback to improve the fighter's performance.

### SUGGESTIONS FOR FURTHER RESEARCH

To create a new trend of investigation, and to respond to the gaps identified in the literature, future research may focus on better understanding the technical-tactical behavioural dynamics. Consequently, we suggest to analyse that the fighter's behaviours in the competitive contexts of Ultimate Full Contact (*i.e.*, efficiencies of long distance, short distance, close distance related with styles stand-up striker, ground striker, submission grappler; attacks preparation or counter-attacks related with its time responses; fights outcomes methods; offensive dynamic efficiency, counteroffensive dynamic efficiency and defensive dynamic efficiency). These technical-tactical demands can help to develop technical-tactical fighting strategies in Ultimate Full Contact. They are also useful for coaches who wish to create training programs and exercises to optimise the fighter's performance. In addition, the results of these suggested studies will be based on specific and representative knowledge obtained through a hybrid combat sport, which will be able to be extrapolated to similar modalities (*e.g.*, Pankration, Free-Fight, Shooto or MMA).

### CONSENT FOR PUBLICATION

Not applicable.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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### REFERENCES

- [1] Loio Pinto FC. Perceção sobre as competências do treinador de desportos de combate [dissertation]. Guarda (Portugal): Inst. Politécnico da Guarda; 2015 Dez. 91 p. Available from: <http://hdl.handle.net/10314/22795>
- [2] Federação Portuguesa de Full Contact. História e desenvolvimento do full contact em Portugal [Internet]. Viseu: FPFC. 2000. Available from: <http://www.angelfire.com/pq/fppff/ultimatefullcontact.htm>
- [3] Federação Portuguesa de Full Contact. Caracterização do full contact, ultimate full contact e conteúdos técnico-táticos. [Internet]. Viseu: FPFC. 2000. Available from: <http://www.angelfire.com/pq/fppff/description.htm>
- [4] Avakian SP, Miarka B, Achour AJ. Análise de frequência das ações técnico-táticas competitivas no taekwondo: uma revisão. RAMA 2017; 11(2): 83-98.
- [5] Cappai I, Pierantozzi E, Tam E, et al. Physiological responses and match analysis of Muay Thai fighting. Int J Perform Anal Sport 2012; 12(3): 507-16. [<http://dx.doi.org/10.1080/24748668.2012.11868615>]
- [6] Kruszewski M, Kruszewski A, Kuźmicki S, et al. Boxing techniques based on the analysis of boxing tournament finals during Olympic Games in London in 2012 JCSMA Medsportpress 2016; 1(2): 61-6. [<http://dx.doi.org/10.5604/20815735.1224961>]
- [7] WBC World Boxing Council. Rules & regulations. [Internet]. Mexico. 1963. Available from: <https://wbcbboxing.com/en/wbc/rules>
- [8] ADCC. Submission Fighting World Federation Official site. [Internet]. UAE. 1998. Available from: <https://adcombat.com/adcc-rules-regulations/>
- [9] Pinto FCL, Neiva H, Nunes C, et al. Ultimate full contact: fight outcome characterization concerning their methods, occurrence times and technical-tactical developments. Int J Environ Res Public Health 2020; 17(19): E7094. [<http://dx.doi.org/10.3390/ijerph17197094>] [PMID: 32998211]
- [10] Del Vecchio FB, Silva JR, Farias CB. Análise temporal de combates de Muay Thai de nível nacional: Efeitos da fase competitiva. RAMA 2015; 10(1): 34-41. [<http://dx.doi.org/10.18002/rama.v10i1.1635>]
- [11] Kazemi M, Perri G, Soave D. A profile of 2008 Olympic Taekwondo competitors. J Can Chiropr Assoc 2010; 54(4): 243-9. [PMID: 21120015]
- [12] Kirk C, Hurst H, Atkins S. Comparison of the training loads of mixed martial arts techniques in isolated training and open sparring. JCSMA Medsportpress 2015; 1(2): 6:15-20. [<http://dx.doi.org/10.5604/20815735.1174226>]
- [13] Marcovic G, Vucetic V, Cardinale M. Heart Rate and lactate responses to Taekwondo fight in elite women performers. Biol Sport 2008; 25(2): 93-9.
- [14] Menescardi C, Bermejo JL, Herrero C, et al. Diferencias técnico-táticas en taekwondistas universitarios según sexo y categoría de competición. RAMA 2012; 7(2): 1-11. [<http://dx.doi.org/10.18002/rama.v7i2.82>]
- [15] del Vecchio FB, Hirata SM, Franchini E. A review of time-motion analysis and combat development in mixed martial arts matches at regional level tournaments. Percept Mot Skills 2011; 112(2): 639-48. [<http://dx.doi.org/10.2466/05.25.PMS.112.2.639-648>] [PMID: 21667772]
- [16] Miarka B, Brito CJ, Amtmann J. Performance probabilities and outcome effects in technical-tactical factors with bout phase changes of mixed martial arts. Int J Perform Anal Sport 2017; 17: 510. [<http://dx.doi.org/10.1080/24748668.2017.1360103>]
- [17] Slimani M, Davis P, Franchini E, Moalla W. Rating of perceived exertion for quantification of training and combat loads during combat sport-specific activities: A short review. J Strength Cond Res 2017; 31(10): 2889-902. [<http://dx.doi.org/10.1519/JSC.0000000000002047>] [PMID: 28933715]
- [18] Tabben M, Miarka B, Chamari K, Beneke R. Decisive moment: A metric to determine success in elite karate bouts. Int J Sports Physiol Perform 2018; 13(8): 1000-4. [<http://dx.doi.org/10.1123/ijsp.2017-0526>] [PMID: 29345545]
- [19] Amtmann JA. Self-reported training methods of mixed martial artists at a regional reality fighting event. J Strength Cond Res 2004; 18(1): 194-6. [PMID: 14971990]
- [20] Castelo J, Barreto H, Alves F, et al. Metodologia do treino desportivo. 1st ed. Lisboa: FMH Universidade Técnica de Lisboa 1996.
- [21] Barna T. Elite wrestlers' orientation to tactical information. Int J Wrestl Sci 2013; 3(1): 10-6.
- [22] López-González D. Technical-tactical performance in greco-roman wrestling: analysis of 2013 Senior World Championships through multivariate analysis. Int J Wrestl Sci 2014; 4(1): 95-110. [<http://dx.doi.org/10.1080/21615667.2014.10879004>]
- [23] Miarka B, Julio UF, Del Vecchio FB, et al. Técnica y táctica en Judo: una revisión. RAMA 2010; 5(1): 91-112.
- [24] López-González DE, Miarka B. Reliability of a new time-motion model based on technical-tactical interactions for Wrestling Combats. Int J Wrestl Sci 2013; 3: 21-34. [<http://dx.doi.org/10.1080/21615667.2013.10878967>]
- [25] De la Fuente A, Castejón FJ. An evaluation of categories for tactical actions: a preliminary study of combat analysis in taekwondo. Cult Cienc Deporte 2016; 11(32): 157-70. [<http://dx.doi.org/10.12800/ccd.v11i32.715>]
- [26] Boguszewski D. Dynamics of judo contests performed by top world judokas in the years 2008-2012. JCSMA 2014; 1(2): 31-5. [<http://dx.doi.org/10.5604/20815735.1127451>]
- [27] Kalina RM, Kulesza A, Mysłowski B, et al. Dynamics of judo, boxing and taekwondo contests performed by finalists of Olympic Games in Sydney. Sci. Częstochowa: Publishing Section of the Faculty of Management of the Częstochowa University of Technology 2004; pp. 326-31.

- [28] Santos VG, Franchini E, Lima-Silva AE. Relationship between attack and skipping in Taekwondo contests. *J Strength Cond Res* 2011; 25(6): 1743-51. [http://dx.doi.org/10.1519/JSC.0b013e3181ddfb0f] [PMID: 21512402]
- [29] Silveira Coswig V, Hideyoshi Fukuda D, de Paula Ramos S, Boscolo Del Vecchio F. Biochemical differences between official and simulated mixed martial arts (MMA) matches. *Asian J Sports Med* 2016; 7(2): e30950. [http://dx.doi.org/10.5812/asjms.30950] [PMID: 27625756]
- [30] Coswig VS, Ramos SdeP, Del Vecchio FB. Time-motion and biological responses in simulated mixed martial arts sparring matches. *J Strength Cond Res* 2016; 30(8): 2156-63. [http://dx.doi.org/10.1519/JSC.000000000001340] [PMID: 26817739]
- [31] Karpman S, Reid P, Phillips L, Qin Z, Gross DP. Combative sports injuries: An Edmonton retrospective. *Clin J Sport Med* 2016; 26(4): 332-4. [http://dx.doi.org/10.1097/JSM.0000000000000235] [PMID: 26327287]
- [32] Miarka B, Vecchio FB, Camey S, Amtmann JA. Comparisons: Technical-tactical and time-motion analysis of mixed martial arts by outcomes. *J Strength Cond Res* 2016; 30(7): 1975-84. [http://dx.doi.org/10.1519/JSC.0000000000001287] [PMID: 26670995]
- [33] Miarka B, Cury R, Julianetti R, *et al.* A comparison of time-motion and technical-tactical variables between age groups of female judo matches. *J Sports Sci* 2014; 32(16): 1529-38. [http://dx.doi.org/10.1080/02640414.2014.903335] [PMID: 24720553]
- [34] Adam M, Klimowicz P, Pujszo R. Judoists' tactical and technical efficiency during the World Championships in 2014 and 2015. *Balt J Health Phys Act* 2016; 8(2): 19-28. [http://dx.doi.org/10.29359/BJHPA.08.2.02]
- [35] Miarka B. Demandas técnico-táticas e fisiológicas de combates da luta olímpica. *RAMA* 2016; 11(1): 18-31. [http://dx.doi.org/10.18002/rama.v11i1.3309]
- [36] Chen WY, Wu SK, Song TF, *et al.* Perceptual and motor performance of combat-sport athletes differs according to specific demands of the discipline. *Percept Mot Skills* 2017; 124(1): 293-313. [http://dx.doi.org/10.1177/0031512516681342] [PMID: 27932534]
- [37] Menescardi C, Falco C, Hernández-Mendo A, Morales-Sánchez V. Talent and creativity of taekwondoists winners of the 2016 Summer Olympics. *Sustainability* 2020; 12: 41-85. [http://dx.doi.org/10.3390/su12104185]
- [38] Ito K, Hirose N, Tamura M, Nakamura M. Alterations in kumite techniques and the effects on score rates following the 2013 International Judo Federation rule revision. *Arch Budo Sci Mart Arts* 2015; 11: 87-92.
- [39] Ito K, Hirose N, Nakamura M, Maekawa N, *et al.* The transformation of technical-tactical behaviors from hand techniques used in attacking below belt after the 2010 International Judo Federation rule revision. *Arch Budo Sci Mart Arts* 2013; 9: 1-6. [http://dx.doi.org/10.12659/AOB.883732]
- [40] Adam M, Smaruj M, Tyszkowski S. The diagnosis of the technical-tactical preparation of judo competitors during the World Championships (2009-2010) in the light of new judo sport rules. *Arch Budo Sci Mart Arts* 2011; 7: 5-8.
- [41] Santos DAD, Miarka B, Bello FD, *et al.* 10-Years on time-motion and motor actions of paired mixed martial arts athletes. *Int J Sports Physiol Perform* 2018; 30: 1-13. [PMID: 30160583]
- [42] James LP, Robertson S, Haff GG, Beckman EM, Kelly VG. Identifying the performance characteristics of a winning outcome in elite mixed martial arts competition. *J Sci Med Sport* 2017; 20(3): 296-301. [http://dx.doi.org/10.1016/j.jsams.2016.08.001] [PMID: 27569006]
- [43] Bello FD, Brito CJ, Amtmann J, Miarka B. Ending MMA combat, specific grappling techniques according to the type of the outcome. *J Hum Kinet* 2019; 67: 271-80. [http://dx.doi.org/10.2478/hukin-2018-0081] [PMID: 31523324]
- [44] Chernozub A, Korobeynikov G, Mytskan B, *et al.* Modelling mixed martial arts power training needs depending on the predominance of the strike or wrestling fighting style. *J Martial Arts Anthropol* 2018; 18(3): 28-36.
- [45] Amtmann JA, Amtmann KA, Spath WK. Lactate and rate of perceived exertion responses of athletes training for and competing in a mixed martial arts event. *J Strength Cond Res* 2008; 22(2): 645-7. [http://dx.doi.org/10.1519/JSC.0b013e318166018e] [PMID: 18550986]
- [46] Kirk C, Hurst HT, Atkins S. Measuring the workload of mixed martial arts using accelerometry, time motion analysis and lactate. *Int J Perform Anal Sport* 2015; 15(1): 359-70. [http://dx.doi.org/10.1080/24748668.2015.11868798]
- [47] Groniek P, Wielinski D, Groniek J. Genetic and non-genetic determinants of aggression in combat sports. *Open Life Sci* 2015; 10(1): 7.
- [48] Maszczyk A, Golaś A, Pietraszewski P, *et al.* Neurofeedback for the enhancement of dynamic balance of judokas. *Biol Sport* 2018; 35(1): 99-102. [http://dx.doi.org/10.5114/biolSport.2018.71488] [PMID: 30237667]
- [49] Miarka B, Coswig V, Brito JC, *et al.* Comparison of combat outcomes: technical and tactical analysis of female MMA. *Int J Perform Anal Sport* 2016; 16: 2. [http://dx.doi.org/10.1080/24748668.2016.11868907]
- [50] Miarka B, Brito CJ, Bello FD, Amtmann J. Motor actions and spatiotemporal changes by weight divisions of mixed martial arts: Applications for training. *Hum Mov Sci* 2017; 55: 73-80. [http://dx.doi.org/10.1016/j.humov.2017.07.009] [PMID: 28779598]
- [51] Kruyning E, De Jong M. *Mma, the essentials of mixed martial arts*. 2014.
- [52] Adam M, Pujszo R, Kuźmicki S, *et al.* MMA fighters' technical-tactical preparation – fight analysis: a case study. *JCSMA* 2015; 6(2): 35-41. [http://dx.doi.org/10.5604/20815735.1174229]
- [53] Antonietto NR, Bello FD, Carrenho Queiroz AC, *et al.* Suggestions for professional mixed martial arts training with pacing strategy and technical-tactical actions by rounds. *J Strength Cond Res* 2019; 23. [http://dx.doi.org/10.1519/JSC.0000000000003018] [PMID: 30694967]
- [54] Gibson JJ. *The ecological approach to visual perception*. Mahwah, NJ: Lawrence Erlbaum Associates 1979.
- [55] Krabben K, Orth D, van der Kamp J. Combat as an interpersonal synergy: An ecological dynamics approach to combat sports. *Sports Med* 2019; 49(12): 1825-36. [http://dx.doi.org/10.1007/s40279-019-01173-y] [PMID: 31502140]
- [56] de Quel OM, Bennett SJ. Perceptual-cognitive expertise in combat sports: a narrative review and a model of perception-action. *Rev Int Cienc Deporte* 2019; 58(15): 323-38. [http://dx.doi.org/10.5232/ricyde2019.05802]
- [57] Russo G, Ottoboni G. The perceptual – cognitive skills of combat sports athletes: A systematic review. *Psychol Sport Exerc* 2019; 44: 60-78. [http://dx.doi.org/10.1016/j.psychsport.2019.05.004]
- [58] Mahlo F. *Acto Tático no jogo*. 1<sup>st</sup> ed. Lisboa: Compendium 1997.
- [59] Castelo J, Barreto H, Alves F, *et al.* *Metodologia do treino desportivo*. 1st ed. Lisboa: FMH Universidade Técnica de Lisboa 1996.
- [60] Bolotin A, Bakayev V. Pedagogical practice for development of coordination potential of MMA fighters and estimation of its efficiency. *J Hum Sport Exerc* 2018; 13(1): 72-88. [http://dx.doi.org/10.14198/jhse.2018.131.08]