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The efficiency and transversality of traditional boxing skills to several full-contact combat sports: a narrative review

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Abstract

Background and Study Aim: Despite the well-known efficiency of the boxing art, research focused on the effectiveness of boxing skills used in other full-contact combat sports remains limited. Therefore, this study aimed is knowledge about the effectiveness of boxing skills in other full-contact combat sports.

Material and Methods: The critical analyse was based on qualified 57 articles. The search was performed in the databases Web of Science, PubMed, Scopus, and Google Scholar using a Boolean operator through specific combinations of keywords. Narrative review using the following approach was performed: i) characterizing the technical-tactical basics of boxing skills in attack, counterattack (as a specific form of defence), and defence (other way of defence than by counterattack); ii) reporting their use ("how?", "why?", "when?") according to the characteristics and rules of combat sports other than Western boxing; iii) characterizing the conditional, coordinative, and psychological capabilities adequate to maintain the technical-tactical performance of boxing throughout the combat.

Results: Combinations of technical and tactical preparation of boxers with various elements of the impact of training on their organism are emphasized: coordination, synchronization of segmental and spatio-temporal movements; adjusted physical efforts (especially high-intensity intermittent); cognitive and ecological dynamics, such as perception, concentration, anticipation, timing, opportunities seizing, adequate and automated resources, adaptation or creativity. The potential of boxing skills is extended to other compatible combat sports.

Conclusions: Traditional/classic boxing skills are efficient method of attack/counterattack and defence in full-contact combat sports, being the blows (i.e., fist strikes) that most contribute to the outcomes of the fights by knockout. Additionally, boxing skills support the performance of other combat skills (e.g., controlling distances, establishing fluid and powerful combinations, preparing kicks, knee strikes or takedowns in an unpredictable and fast way, facilitating anticipated or simultaneous counterattacks). This study offers relevant references to improve the intervention of coaches and consequently optimize and maximize the performance of fighters, as well as an interesting framework for future research.

Keywords: combat sports • kickboxing • pankration • punching efficiency • sambo • sanda • ultimate full contact

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INTRODUCTION

Western boxing or boxing is defined as a "Noble Art" and "Sweet Science", due to the requirement that boxers be technical-tactical and scientific in their actions respecting ethical rules and martial principles/fighting spirit [1]. As in other combat sports, the success of offensive, counter-offensive, and defensive dynamics results from a set of efficient technical-tactical actions, which depend on fighting dynamic, cognitive, and ecological factors [2-8].

Boxing is a complex full-contact combat sport, characterized by stand-up fist fighting (i.e., jab, cross, hook, uppercut, swing, overhand, all in single or combinations way) associated with defensive actions (i.e., slipping, bobbing, dodging, weaving, parrying, cover-up, blocking, pulling away, clinching, ducking, footwork, and displacements) and control stances (i.e., orthodox – right-handed and southpaw – left-handed), as well as balance, individual fighting styles and proper distances (i.e., long, medium, and short ranges) [9, 10, 4, 8]. For this reason, it is essential that athletes have a high perceptual ability in order to retain pertinent information before and during the opponent's attacks (counterattacks) to decide and act appropriately [11, 2, 4, 8]there has been considerably less consideration of psychological factors. Here, we present a narrative review of literature related to perceptual-cognitive skill in combat sports that require the athlete to score points by hitting or touching the opponent's body with the hands, feet or weapon: boxing, French boxing, fencing, kung fu (wushu. This phenomenon of perception-action depends on the distances, progression of attacks, opponent's reactions and individual skills [11, 2, 4, 8]. Furthermore, the efficiency of the dichotomy of technical skills performed by the upper limbs requires a high level of coordination skills [12] synchronized with trunk and lower limb movements [13].

As in any full-contact combat sport, the main objective is to be efficient in attacks and counterattacks, hitting the opponent correctly and accurately, avoiding getting hit [14, 15, 2, 4] through rational skills and economic movements, increasing the technical-tactical variability and, consequently, its complexity, while hiding one's intentions from the opponent [16]. This is the essence of boxing sports [15, 16]. In fact, anticipating the opponent's movements with precise and adequate actions and seizing the opportunities is decisive to gaining an advantage in combat [2, 4, 8]. Consequently, technical performance effectiveness, total combinations – lead and rear hand punches, counterpunches, punches to the head and body, higher frequency of technical movements, and defensive and offensive skills effectiveness are aspects evidenced by winning boxers [17, 18].

Boxing skills were first included in a full-contact hybrid combat sport, known as "Pankration" at the ancient Olympic Games of 776 BC [19, 20], and it was established as an Olympic modality "*Pugilato*/Boxing" at the Olympic Games of 688 BC (XXIII Olympics) [20, 10, 21].

In the early 1970s, a combat sport was established that combined Western boxing skills with martial arts skills, known as "Full-Contact", later kickboxing, and more recently, other full-contact hybrid combat sports (e.g., Ultimate Full-Contact, Modern Pankration, *Vale Tudo*, Free-Fight and Mixed Martial Arts; MMA, in fact, neo-gladiatorship – see glossary) [22, 2, 4, 6, 7]. In addition, there are other combat sports (e.g., Muay thai/

Contact sport – *noun* any sport in which physical contact between players is an integral part of the game, e.g. boxing, rugby or taekwondo [58].

Combat sport – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [58].

Muay thai – or *thai boxing*, originates from southern Asia (not only from Thailand, but also from Burma, Cambodia, Vietnam and Malaysia). It was inspired by fighting skills used on battle fields during wars conducted by the Thais in the twelfth and thirteenth century AD. Apart from a fight with use of various weapons, during hand-to-hand fighting warriors used ***kaad chuek*** (wrappings around hand and fore-arm) which were hardened and studded with gravel to cause the greatest damage possible martial art originally from Thailand characterized by the combined use of fists, elbows, knees, shins and feet [59].

Sambo – is a Russian **martial art** and **combat sport**. The word "SAMBO" is an **acronym** for ***SAM****ozashchita* ***Bez O****ruzhiya*, which literally translates as "self-defense without weapons". Sambo is relatively modern since its development began in the early 1920s by the **Soviet Red Army** to improve their hand-to-hand combat abilities It was intended to be a merger of the most effective techniques of other martial arts. The pioneers of Sambo were **Viktor Spiridonov** and **Vasili Oshchepkov**. Oshchepkov died in prison as a result of the **Great Purge** after being accused of being a Japanese spy. Oshchepkov spent several years living in Japan and training in **judo** under its founder **Jigoro** Kano [60].

thai boxing, sanda/sanshou, combat sambo) in which fighters perform boxing skills [23, 15, 24]. However, in these modalities more fist techniques than those used in Western boxing are allowed, such as whipping fist in sanda [15] or spinning back fist in combat sambo, kickboxing, Muay thai, or ultimate full-contact [4, 25, 26, 8]. In fact, punch skills are the most relevant basic moves in striking or hybrid combat sports [2-8].

Boxing and the aforementioned combat sports are non-cyclic skill modalities, characterized as intermittent high-intensity sports, in which high-intensity conditioning plays a relevant role in the performance of athletes [19, 20, 27-29, 21, 17, 30, 22, 31, 18, 23, 25, 26, 5-7, 32, 24, 8]. Although fights are characterized by an essentially anaerobic activity with constant short-duration high-intensity efforts (e.g., brief punches of extreme power), aerobic metabolism also plays an important role in the recovery process [33-37, 5-8].

Even so, all these sports are characterized by having a complex structure, composed of a high technical-tactical repertoire [4-8], and for this reason they require well-developed technical-tactical skills associated with high level of physical and physiological fitness (e.g., conditional, coordination, and), in order to withstand the demands imposed by the fight [38, 35, 31, 5-8].

The diversity of technical-tactical resources leads to a context of high tenacity, variability, and unpredictability. Particularly in full-contact hybrid combat sports, the complexity is even greater, as it can be fought standing-up (in vertical posture) and also on the ground (in horizontal posture), in addition to allowing striking skills (i.e., punches, kicks, elbows, knees) and submission grappling (i.e., takedowns, throws, joint locks and chokes) [2-4, 26, 5-8].

Moreover, all the sports aforementioned articulate a wide variety of isolated and combined actions with powerful blows, in which the knockout can happen at any time [2-8]. This is in line with different combat sports studies, in which the knockout outcomes are mostly through fist strikes (i.e., boxing punches) to the head, although hitting the body (i.e., liver and stomach) is also effective to win by knockout [39, 40, 25, 3]. This increases the emotional and psychological pressure of fights [5-7].

In fact, fights involve a high number of complex boxing skills, used in an offensive or counter-offensive and defensive dynamics, combining punches and counterpunches with defensive actions [2-8]. Thus, the multifaceted resources of fighters (i.e., technical-tactical skills, physical and psychological capabilities) are necessary to achieve combat objectives [2-8]. In this context, boxing skills are applied with their particularities and fundamentals (e.g., dexterity, fluidity, styles, distances, strategy, anticipation, control, perception, decision-making, opportunities-seizing, efficiency, automation, coordination, displacements, creativity, precision, timing, adaptation, balance, agility, optimal endurance, strength, and speed) [9, 10, 2-8]. Boxing punches are biomechanically complex actions (i.e., kinetics and kinematics) that involve synchronized movements of the arms, hips, trunk, and legs, in which the strike efficiency results largely from lower segment/limb movements and trunk/hip rotations [13, 10, 41].

As boxing skills are the most distinctive and traditional form of fist fighting based on scientific principles, the following questions arise: to what extent boxing skills are crucial to win any full-contact fight with different rules (e.g., kickboxing, muay thai, ultimate full-contact, pankration, MMA)? "How?", "Why?", and "When?" boxing skills are applied to be efficient and effective?

Therefore, this study aimed is knowledge about the effectiveness of boxing skills in other full-contact combat sports.

MATERIAL AND METHODS

Literature Search Strategies

The available literature on the topic was investigated by searching the Web of Science, PubMed, Scopus, and Google Scholar electronic databases. Articles published in 2022 or earlier were considered. The search strategy consisted of search words that combined one of the three primary keywords ("boxing", "fists skills" and "punch skills"), with a second keyword ("combat sports", "kickboxing", "full-contact", "ultimate full-contact", "muay thai", "pankration", "free-fight", "combat sambo", "sanda", "sanshow", and "MMA mixed martial arts" using the boolean operator. The inclusion criteria for these articles were: 1) articles that characterized the modalities in question

Tactics – *plural noun* the art of finding and implementing means to achieve immediate or short-term aims [58].

Technique – *noun* a way of performing an action [58].

Knockout – *noun* **1.** (*in boxing*) a punch that knocks an opponent down for a count of ten and so wins a contest **2.** a sports competition in which a person or team beaten in one game or match is eliminated from the entire competition [58].

Timing – the choice, judgement, or control of when something should be done (e.g. the moment of the attack in boxing, judo).

Exercise intensity – in order to improve physical fitness, exercise must be hard enough to require more effort than usual. The method of estimating appropriate training intensity levels varies with each fitness component. Cardiovascular fitness, for example, requires elevating the heart-rate above normal [61].

Training intensity – the effort of training. A number of methods are used to establish training intensities which give maximum benefits. These include the lactic acid method, minute ventilation method, and target heart-rate [61].

Neo-gladiator – a person who trains mix martial arts (MMA) and similar forms of hand-to-hand fighting that do not meet the definition of sport according to the Olympic Charter [62].

Counterattack – Tadeusz Kotarbiński (former of agonology – general theory of struggle) pays attention onto a seeming paradoxically of a statement: "(...) that any defence is a certain form of attack and only the reciprocal is not a truth not any attack is a defence" [62, p. 130] (...) As the defender faces an alien's attack, so he or she counteracts changes, to that the enemy is tending. As follows in defending he or she attacks (in an accepted sense of attack), even if he or she protects himself or herself, lays barriers, etc. [62]. **Counterattack** – according to the criteria of agonology – is the basic form of defence – see also [63-65].

Standing strike – in the jargon of combat sports, a fight in a vertical posture (position).

Ground fight – in the jargon of combat sports, a fight in a horizontal posture (position).

Plyometrics –*noun* a free body movement exercise system that uses no weights or machines and emphasises callisthenics and repeated movements such as jumping high off the ground [58].

in terms of technical-tactical, physical, and physiological skills; 2) articles that referred to technical-tactical boxing actions applied in different full-contact combat sports, their effectiveness, how, why, and when they are applied. The articles were selected based on the evaluation of the title and abstract. Articles were excluded if: 1) they did not meet the search criteria; 2) they were studies of combat sports that did not fully perform boxing skills. In total, 102 articles were considered relevant for this study. All articles were read in detail and evaluated for relevance and quality by two senior researchers with experience and relevant publications in the field. All articles that did not meet the criteria were excluded. After this procedure, 57 articles remained for analysis (Figure 1).

Narrative review using the following approach was performed: characterizing the technical-tactical basics of boxing skills in attack, counterattack (as a specific form of defence – m see glossary), and defence (other way of defence than by counterattack).

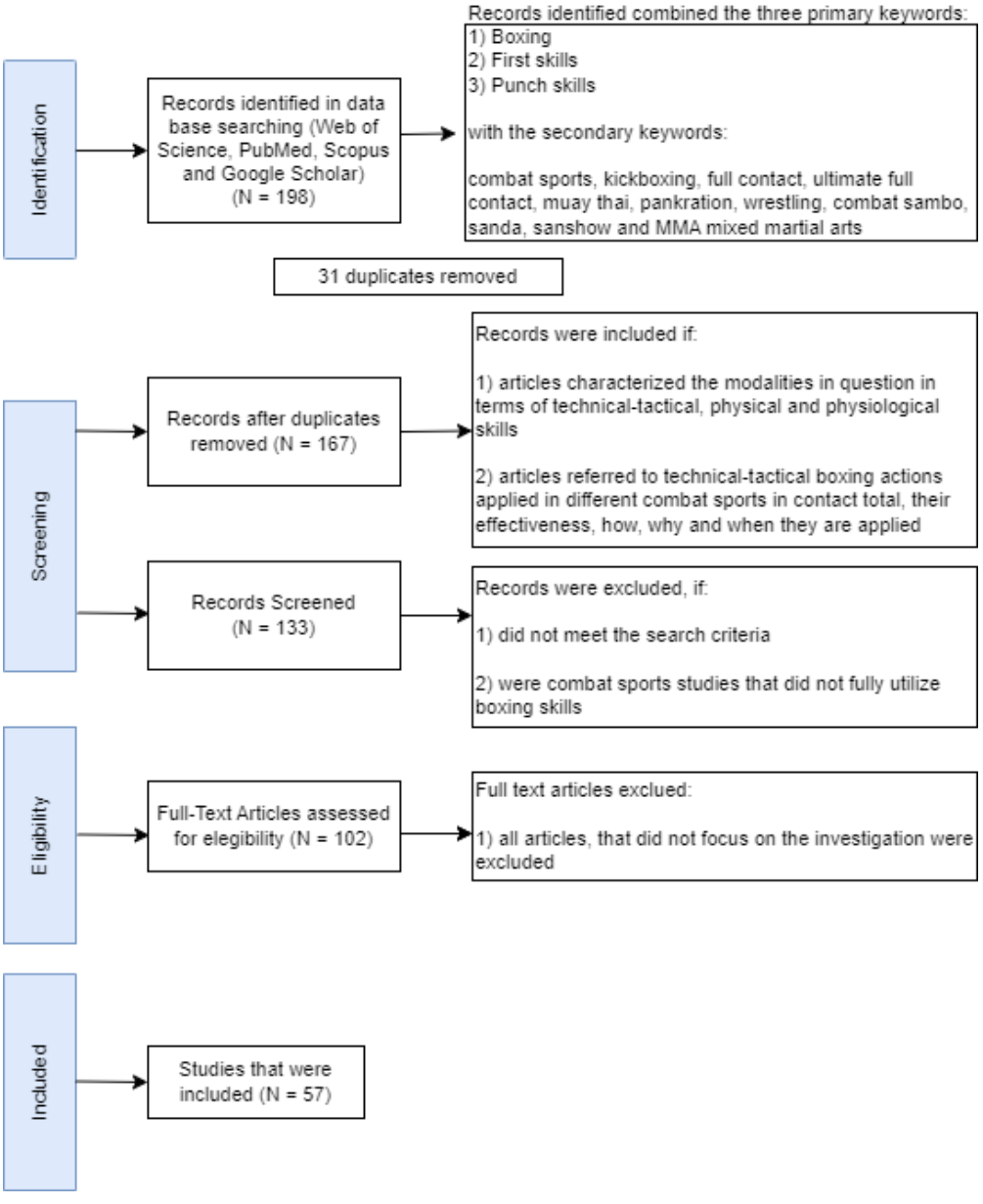

Figure 1. PRISMA 2009 flow diagram.

RESULTS

Boxing skills efficiency in other combat sports

Boxing is a fighting system with a martial history, tradition and undeniable virtue in the close-combat preparation of warriors and with relevant sports development [1]. In fact, it is a system that has proven to be effective and efficient on the battlefield, in street self-defence, and in sport competition against other forms of combat, causing several styles of full-contact combat sports to develop their fist techniques similar to boxing art skills [1]. Indeed, in the technical-tactical repertoires of percussion styles and hybrid styles, the use of boxing skills is verified, for example, excellent sanda athletes have revealed a high frequency of boxing skills, especially the use of jabs and hooks [42]; an analysis of 170 international ultimate full-contact fights, between 340 top athletes in the world (experts in different combat sports/martial arts), showed that during the stand-up fight, there was higher frequency and efficiency of boxing skills (i.e., punches) in relation to other striking skills (i.e., kicks, knees, elbows) [4].

This study revealed a significant advantage of winners over losers in the use of boxing strikes [4]. Even in the ground fight, fist techniques (i.e., ground and pound) were superior to submission techniques (i.e., chokes and joint locks) [40, 4]. Thus, its clever and correct use has proven to be a crucial strategic resource for success in combat [23, 2, 4, 6-8].Consequently, the efficiency and effectiveness of fist strikes in different full-contact combat sports depend on the following factors: i) The technical-tactical fundamentals of boxing skills in attack, counterattack and defence; ii) Their use ("how?", "why?", "when?") according to the characteristics and rules of combat sports other than Western boxing; iii) The conditional, coordinative and psychological capabilities adequate to maintain boxing technical-tactical performance throughout the combat.

The technical-tactical fundamentals of boxing skills in attack, counterattack and defence

Fighting is one of humanity's oldest activities, but the instinctive use of fists is far from being exclusively derived from "boxing", which to be dominated requires a lot of dedication, study, and effort [9]. The technical-tactical bases are the prerequisites for the performance of all combat dynamics. In fact learning the fundamental details is essential for the development of the most refined techniques [9, 10]. These are structural and functional standards, which must be properly assimilated, perfected, and developed so that combat objectives are achieved. First of all, a stable and adequate guard stance (i.e., orthodox – right-handed and southpaw – left-handed) is necessary, always keeping the frontal framing with the opponent and focusing on the opponent's eyes or chest to predict his movements considering the constant spatio-temporal changes [9, 10, 2-8]. This position must ensure the protection of strategic anatomical targets at all times (e.g., jaw, liver). In addition, it must allow trunk, hips and head movements as well as fluid and fast displacements (i.e., sliding steps – right and left sides, forward and pushback; diagonal steps and turns / pivots), solid balance on both feet by the pendulum effect and creating propulsion and impulsion of the legs to generate force from the ground for the punch efficacy [43, 44, 2-8]. In addition, rotating the body (i.e., trunk, hips) allows all the weight to be behind the blows, that is, transferring the weight with the movement to increase the power of the punching [9]. Finally, the relaxation of the body (shoulders and arms) and its contraction on impact will produce a ballistic/explosive strike. The movements must be quick to cover the openings/gaps caused by their own execution and thus avoid the connection of counterpunches by the opponent because boxing is a case of action and interaction, in which speed distinguishes the absolute best [9].

The above mentioned references (i.e., correct posture and movements) are the fundamental basis to efficiently perform all boxing skills (e.g., jab, cross, hook, uppercut, swing, overhand; slipping, bobbing, parrying, covering-up, blocking, pulling away, footwork, and displacements) in offensive, counter-offensive and defensive dynamics, and keep control over the opponent throughout the fight [9-10, 2-8]. In fact, they are biomechanical aspects developed based on kinematics and kinetics that allow greater agility, fluidity, balance, safety, rhythm, strength, speed, and power in blows [10, 43, 44, 6, 8].

Subsequently, after automating the fundamental bases and technical standards, each athlete will develop their fighting style according to their own anthropometric characteristics and the respective particularities of combat sports. The smartest strategy is to take advantage of

the physical attributes of each athlete [9, 45] so that later they can develop technical-tactical efficiency and, consequently, competitive performance [10, 45]. These skills can be developed through training methods under the cognitive and dynamic ecological perspectives, including analytical and integrated training through systematic repetition of exercises (increasing their complexity) and conditioning or formal partner sparring [5, 6, 8]. The first method is centred on the individual and the activity (e.g., skills automation, memory, experience), while the second method is centred on the individual interaction – context, focused on the representativeness or contextualization [5, 6, 8].

In this matter, recent studies emphasize a mixed model of training, with practical applications with repercussions on the structural or biomechanical and functional technical-tactical development representative of the competition [5, 8]. It consists of assisted training using plastrons (boxing mitt workout/focus pad training) in which the coach constantly interacts with the athlete, assuming the role of the opponent in a more or less unpredictable and complex way [5, 8].

Boxing skills use ("how?", "why?", "when?") according to the characteristics and rules of combat sports other than Western boxing

How boxing skills are performed

Boxing skills in single or combinations punches/counterpunches and defences are used considering the particularities mentioned in the previous item so that they are efficient and effective. In this sense, all technical-tactical actions must be coordinated with each other (e.g., punches coordinated with footwork/displacements and trunk/hip moves; counterpunches coordinated with slipping/dodging) [9, 13, 41, 10, 2, 4, 6, 8]. That is, optimally synchronizing all body segments to perform the punch with better combinations of velocity and force [44].

In addition, any action requires anticipating the opponent's actions, considering the consequences and needs [2, 4, 6, 8]. It should be noted that being unpredictable and versatile in attacks is also an essential factor in performance [2, 4, 6, 8]. Additionally, being quick, accurate, and flexible in the use of boxing skills is also one of the requirements for success [23].

Nevertheless, the complexity of these skills increases with the degree of variability, diversity and technical-tactical resources [2, 4-6, 8]. Thus, it is necessary to take into account the rules and technical features of each modality as they also allow the use of other skills (e.g., spinning back hands/fists, grabs, grips, kicks, knees, elbows, takedowns, throws, chokes, joint locks) [4, 8], considering that trying to punch in a context in which kicks, knees, throws or submission skills are also allowed is very different from when they are not [4, 8]. Different rules require different profiles of perceptual-motor performance which leads to differences in dynamics [2, 4, 8].

Therefore, the punch attack must be carried out considering the best defence at the same time it is performed, according to the possible counterattacks (e.g., punches, kicks, knees, throws) [2, 4, 6, 8]. Regarding counterpunches, these can take different forms of execution: anticipated, simultaneous, and posterior against the opponent's attack [2]. In this matter, a recent study showed that the anticipated counterattack is the most efficient form used by both winners and losers, followed by the simultaneous and posterior [2]. However, their frequency was used differently between winners and losers: the winners performed more often the anticipated, followed by the simultaneous and, finally, the posterior, while the inverse was observed in the context of the losers [2]. It becomes clear that fighting on counterpunching is an effective combat strategy [2, 3]. This is the art of exploring areas exposed by the opponent when he attacks, turning his attack into an advantage [9].

Why boxing skills are performed

Boxing skills have proven to be quite efficient and effective in ultimate full-contact, performed by expert fighters from different combat sports [2-4]. Its use aims to create adequate distances to carry out defences and precise attacks/counterattacks to strategic anatomical points [2-4]. In fact, punching skills are the cause of a significant number of knockout in full-contact combat sports [39, 40, 3]. Moreover, evasion skills allow the fighter to unbalance the opponent and also to keep the upper segments free to perform anticipated or simultaneous counterpunches, which have proven to be the most efficient ways to counterpunch [2, 8].

In the art of boxing, the "left hook", when well executed, is considered to be the most devastating blow; the "uppercut" becomes more

effective in infighting because it is a characteristic small-space strike, while the "jab" is the most used punch technique (primary boxing blow) [9]. This is a blow that aims to create and keep adequate distances with the opponent to perform other fighting techniques (e.g., cross, kicks, takedowns) [46, 4, 8]. In full-contact hybrid combat sports (e.g., ultimate full-contact, combat sambo, MMA), straight punches (i.e., jab, cross) are the most used and efficient, because they generate favourable distances for the use of kicks and, in short/close distances, the use of grappling (e.g., clinch, arm drag, takedown) limits the use of short punches (i.e., hook, uppercut) [4, 8]. Also, in percussion combat sports (i.e., striking sports) such as sanda/sanshou, an observational study about one of the best fighters showed a success rate of 70% in the use of straight punches, followed by 30% in the use of swing punch [23]. Also another study concludes that straight punches are effective in different combat sports due to the high impact and speed they reach (over 10 m/s) [47].

Boxing skills form quick combinations useful to include other techniques effectively and powerfully, such as: straight punches (i.e., jab, cross); left hook and right low kick/high roundhouse kick; jab and spinning back kick or double takedown [25, 2]. The effectiveness of kicking skills (performed in the sequence of boxing skills) is a result not only of adequate distances, but also of the pendulum effect or counterbalances created by the footwork/displacements and body rotations [2, 8]. Also, using feints (e.g., blows simulation, body movements, drop his/her hands) to create opportunities is an effective combat strategy, causing the opponent to perform the expected actions to counterattack them. Finally, boxing skills allow fighters to fluidly connect all combat skills moves and break the opponent's rhythm [4, 6].

When boxing skills are usually performed

The effectiveness of boxing skills is highlighted as a support for the efficient application of other skills. The winning and most efficient fighters in the ground fighting (i.e., ground striker style or submission grappler style) were the same ones who also showed greater efficiency in the standing strike (i.e., mainly boxing and then kicking) [4].

In addition, the application of boxing skills depends on contextual opportunities but also on the fighter's own boxing potential and intentions, creating the appropriate opportunities and anticipating the consequences [2, 4, 6, 8]. In a study comparing the total values (winners and losers) of different distances (i.e., contextual variation) with styles/skills, higher correlations between specific styles/skills and specific distances are verified, evidencing that fighters choose specific styles and skills according to the perceived distance for the efficiency of the attack. However, the choice of the proper distance by the fighters to perform efficient attacks was also taken into consideration [4].

It is not enough to react spontaneously according to the contextual opportunities without cognitively perceiving, interpreting and deciding on specific and correct actions at the right time, while articulating styles/skills with distances [2, 4]. Thus, the fighters' decision to use boxing skills is the result of the fighter and the fighter-context interaction [4, 8].

The conditional, coordinative and psychological capabilities adequate to maintain the technical-tactical performance of boxing throughout the combat

Full-contact combat sports involve fights with a complex structure and intermittent moments of higher intensity, so they demand multifaceted goals from fighters [5, 7, 8]. In this sense, for fighters to have an efficient technical-tactical performance, it is essential that they develop skills and all conditional capabilities optimally to maintain technical-tactical performance during combat [5, 7, 8].

Fights require the fighter to be well prepared in both anaerobic and aerobic endurance [29, 5, 7, 8]. Lactic and alactic anaerobic system is necessary to support short, fast and powerful actions that are repeated throughout the fight, with Adenosine Triphosphate and Phosphocreatine (ATP-PC) and glycolytic energetic processes (initial 10 seconds and to approximately 120 seconds of maximal intensity) [48, 49, 6]. The Aerobic (Oxidative) system is always present and is important for recovery between the aforementioned vigorous actions and also during the break between rounds (intervals) [48, 49, 6]. In this way, high-intensity interval methods (e.g., circuit training, high intensity interval training (HIIT), and intermittent training) are recommended to improve the physical condition of athletes since through this method it is possible to simultaneously improve the anaerobic and aerobic systems and neuromuscular performance, increasing lactic acid tolerance, ATP-PC energy

sources and the efficiency of oxygen use in recovery between high-intensity actions [15, 34, 28, 48, 50, 51, 32, 52, 53]. According to previous studies, the HIIT program ("short intervals" <60 s) is short sequences of certain repeated exercises under maximum intensity efforts (oxygen consumption ≥90% of maximal oxygen [VO2max]) interspersed with periods of rest through low intensity exercises (15 s exercises & 15 s rest, or respectively: 15- & 30-; 20- & 20-; 10- & 20-) [27, 54, 29, 55]. In addition, the HIIT training with boxing-specific techniques has been shown to be effective to increase the punches frequency during a fight [29, 56, 5-8].

Also, plyometric training methods are recommended to develop explosive actions (e.g., powerful punching combinations) [57, 29, 5]. In addition, through these methods (articulating the time-duration and types of contents and pauses), it will be possible to simultaneously develop other specific qualities such as fluidity, agility, synchronization, coordination, reaction time, fast feet, hand speed [5, 8].

In this sense, it is important to highlight that through training based on specific technical-tactical exercises (e.g., boxing skills), in addition to the development of technical-tactical skills, the conditional and psychological capacities are also optimally developed for the demands of the fight [5, 8]. It is noteworthy that through this process, fighters develop more contextualized capabilities, becoming more energy efficient [5-8]. In addition, cognitive processes adapt to the evolution of effort, as during performance there tends to be an inverse relationship between cognitive demands and lactate production, whose effect is greater in full-contact hybrid combat sports such as combat sambo, in which boxing skills are also allowed [24].

CONCLUSIONS

Full-contact combat sports in hybrid or percussion styles are sports with a complex structure and intermittent high-intensity that have boxing skills and dynamics in common. These skills are performed in combined or isolated way under offensive, counter-offensive or defensive dynamics. The use of boxing skills requires fundamental technical-tactical knowledge from fighters ("how?", "why?", and "when?" to perform) and their improvement and development through training methods that simultaneously develop conditional skills in an optimal way, respecting the characteristics of the individual and the sport.

Boxing skills play an important role during combat, contributing to winning fights. Its correct and adequate use, considering the biomechanical, cognitive, and ecological dynamic bases, provides high efficiency and effectiveness in combat. It should be noted that: i) most knockout outcomes in full-contact combat sports are caused by fist blows, mainly through combinations and counterattacks; ii) boxing skills, mainly straight punches or hooks synchronized with body movements, footwork and displacements, allow the fighters to better control combat distances in the form of performing other techniques (e.g., kicks, knee, takedowns) more imperceptibly with fluidity and power; iii) counterpunches are a very efficient strategy in combat, mainly carried out in advance or simultaneously with the opponent's attacks. The evading/dodging becomes more effective in the pre-execution of these counterattacks as they keep the upper segments free to counterattack.

Suggestion for future studies: to analyse the effectiveness of boxing skills in other combat sports through experiential or observational methodologies. Also, the present methodology can be used to verify, for example, the efficiency and transversality of taekwondo leg techniques to other combat sports.

Practical recommendations using boxing skills

Ultimately, to be successful in full-contact combat sports, it is necessary to master boxing skills, not only for their effectiveness, but also to provide support for the most effective execution of kicks, knees strikes or takedowns.

Thus, it is suggested to develop:

Boxing-specific exercises that promote the improvement and development of boxing skills, respecting the fundamentals of this art (i.e., stances, distances and combat styles, displacements and footwork, dodging, blocks, parries, biomechanical aspects of punching and counterpunching). In order to better automate and increase the efficiency of boxing skills, it is suggested to include specific boxing sessions in training programs.

Exercises that articulate boxing techniques with other specific techniques from different modalities, considering biomechanical, bio informational and functional principles, such as increasing fluidity and power in the lower segments techniques (i.e., kicks, knees). These techniques should be used following an opposing upper segments technique (a punch or last punch of a punching combination, e.g., finish on left punch – kick with right leg or finish on right punch – kick with left leg); to control the distance, one must combine jabs and lead-leg skills; to maintain proper distance for long-range or short-range leg techniques, the fighters must use proper fist strikes (i.e., straight or short punches); to perform throws or other techniques, use fist simulations; to the ground fighting performance. It is suitable to develop punching drills, such as "ground and pound" as it has proven to be the most effective combat strategy to win when fighting on the ground.

Execute technical-tactical skills under loads identical to combat efforts, primarily through high-intensity interval or intermittent methods.

Sparring is the recommended exercise par excellence for its representativeness.

Training with plastrons (boxing mitt workout/ focus pad training) is also excellent as it allows the coach to assume the role of the opponent, creating situations identical to competition (contextualized from an ecological perspective) and at the same time analytically automating the techniques (from a cognitive perspective).

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