

KINESIOLOGY & COACHING

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Study of efficiency: standing work vs. ground-work in amateur MMA matches

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Abstract

Introduction. MMA fighters have progressively coalesced into two groups: strikers and grapplers. The subject of the study is to quantify the importance of takedowns and ground work in amateur competitions.

Methods. The present study analyzed 279 amateur male MMA matches fought in 2018, using the Tukey Honest Significance Differences test (Tukey HSD), and quantifying the relationships between different fighting skills and how matches are won.

Results and Discussion. The winners of the MMA bouts, on average clearly made more takedowns than the losers, since the most frequent situation was winning the fight and making more takedowns than the opponent (69.9%). After performing the chi-square Pearson test, with a p-value of <0.001, the dependence between the variables - way of winning the fight and performing fewer, the same or more takedowns than the opponent - can be observed. Moreover, when the bouts end by decision, submission or ground KO/TKO, the fighters spend more time fighting on the ground than standing. However, when the match is won by stand up KO/TKO most of the match takes place standing up. **Conclusion.** Our results reveal that fighters are most likely to win a match when they employ throws in their standing work, overcoming their opponent. On the other hand, when the victories are via standing KO/TKO, both athletes frequently tie in the number of takedowns; however, when the victory is through submission and KO/TKO via ground and pound, the winner tends to make more takedowns than the loser.

Introduction

Mixed Martial Arts (MMA) is a combat sport that has become popular in recent years thanks to very successful TV shows and “no-rules” challenges. While the origins of MMA can be traced to ancient fighting techniques dating as far back as 649 BC [Woodward 2009], modern MMA developed out of a Brazilian fighting style called *Vale-Tudo* (“anything goes” in Portuguese), where the rules are simplified down to their minimal expression. This led, in 1993, to a martial arts competition organized in order to answer an important question: which martial art disciplines or combat sports are the most effective? [Voinea 2015] The competition was broadcast via a new TV show, Ultimate Fighting Championship (UFC), in which athletes from different styles of martial arts and combat sports competed against one another in a tournament that had few rules, doing away with common

norms such as time limits, boxing gloves and weight classes, while maintaining only basic rules intended to ensure the safety of the fighters [Voinea 2015], and also to make the matches more palatable for a broader television audience. The results of these matches ran counter to many long-held assumptions within the world of martial arts and combat sports [Souza-Junior *et al.* 2015], as ground-grappling fighters, who defeated their opponents via submission, clearly dominated the tournament. The UFC has now become the world’s preeminent MMA promotion company, and is where most of the best MMA fighters compete [Zembura, Zysko 2015].

An MMA match is rather complex and can be separated into three stages: free movement, clinch and ground work. The bout always starts with the free movement stage, characterized by punches and kicks, in which there is no body-to-body contact or gripping. In the second stage, the clinch, the athletes fight to achieve a dominant

grip during the standing phase and thereby pull off a take-down. The last stage is ground work, where the fighters focus on submission via locks and chokes [Kruyning, de Jong 2014] although striking may still be employed. The first stage is therefore characterized by the absence of grips, while in the second and third stages grips are essential. Thus, an MMA bout has two very well-differentiated parts: striking and grappling [Bishop, Bounty, Devlin 2013; dal Bello *et al.* 2019].

Modern MMA is a combat sport that combines traditional and non-traditional martial arts [Bishop, Bounty, Devlin 2013]. Whereas the first MMA athletes were specialists in one particular style and did not train in any other [Schick *et al.* 2010], today the MMA has evolved into a hybridization of fighting styles, supported by techniques from a variety of combat disciplines [James *et al.* 2016]. Establishing which fighting styles are most relevant in MMA is important in order to predict which martial artists are more likely to succeed in the ring, and thus plan fighters' training toward the most effective styles. After analyzing the techniques of 20 UFC champions, it has been found that the most common fighting style among them was wrestling, followed by Brazilian jujitsu and boxing [Hu 2013]. This study also highlighted the variety of techniques of different fighting styles used by these champions. On the other hand, the physiological profile of MMA fighters has been compared with other martial artists, finding that MMA fighters have a physiological profile similar to that of judokas and fighters [Schick *et al.* 2010]. In all these studies, a relationship has been observed between MMA and stand-up grappling sports such as wrestling.

The strategy of an MMA match is determined by the skills of each fighter. Fighters are roughly divided into strikers (who are better at punching and kicking) and grapplers (who are good at takedowns and ground fighting). However, this division is obsolete [Blue 2017]; rather, truly successful fighters must dominate all stages in an MMA match. Despite this, many authors continue to differentiate between grapplers and strikers in MMA [Adam *et al.* 2015; Chernozub *et al.* 2018; Hirose, Pih 2010]. To date, a quantitative procedure for characterizing the style of MMA fighters has not yet been developed [Hackett, Storey 2017].

For a given MMA match, the time spent in each of the stages described above can be used to analyze and determine the strategy, and then define the most efficient fighting style. Time spent on the ground tends to be practically the same as time spent standing, a fact that should be reflected in an optimized training regimen. However, there has been hardly any research into the time spent in the ground-work phase, even though some studies highlight the importance of ground combat to win an MMA match [Del Vecchio, Hirata, Franchini 2011; Miarka *et al.* 2016c].

Analysis and diagnosis based on viewing MMA bouts can be used to provide feedback to coaches and

athletes in order to help enhance athletic performance [Miarka *et al.* 2017]. A statistical analysis of these bouts reveals that there have been significant shifts over time in the technical-tactical process between standing and ground situations over the phases of a match [Miarka *et al.* 2016c]. This type of analysis makes it possible to distinguish the trainable characteristics for better performance, which translates into greater chances of success [James *et al.* 2017].

In this context, several authors have analyzed the way in which bouts are won: by knockout or technical knockout (KO/TKO), submission (opponent surrenders) or by decision (when time is up, the referees call the match). After analyzing MMA athletes from the UFC in the years 2012 and 2013, it was found that 72% of bouts ended by decision, 16% in KO/TKO and 11% in submission [Miarka 2016a]. Another study [Miarka *et al.* 2016c] analyzes UFC fights in the men's category in 2014, where it can be seen how the percentage of bouts ending by decision had risen to 85%, as those that end in KO/TKO or submission had fallen to 8% and 6%, respectively. Finally, UFC bouts from 1993 to 2008 were analyzed [Garcia-Bastida 2014], establishing two groups: on the one hand fights between 1993 and 2001, where only 19% ended by decision, 36% in KO/TKO, and the largest number, 41%, ended in submission. By contrast, between 2001 and 2008, ending by decision rose to 29%, KO/TKO rose to 42%, and submission dropped to 26%.

In recent years, MMA's popularity has grown significantly [Bishop *et al.* 2013; James 2018; Seidenberg 2011], being one of the fastest growing for-profit and social sports in history [Garcia-Bastida 2014]. Although this burgeoning popularity has prompted an increase in research surrounding the sport, there are still many questions about the best training strategy and structure, which can only be answered through detailed research. While several studies have attempted to establish the bearing of different specific techniques on the result of a match [Crossley 2015; dal Bello *et al.* 2019; Garcia-Bastida 2014; Miarka *et al.* 2017], the impact of style on success in MMA has never been quantitatively investigated [Hackett, Storey 2017].

The majority of the research carried out focuses on high-level professional MMA fights, mainly studying the UFC at the international level [dal Bello *et al.* 2019; Garcia-Bastida 2014; Hu 2013; James *et al.* 2017; Miarka *et al.* 2017; Miarka *et al.* 2016a; Miarka *et al.* 2016b], but also professional MMA at the regional and national levels [Del Vecchio, Hirata, Franchini 2011; Kirk, Hurst, Atkins 2015].

On the other hand, there are very few studies on amateur MMA [James 2018; Schick *et al.* 2010], and we have not found any research into amateur MMA that uses data drawn from real competitions. This constitutes a significant gap in the literature, as such studies are necessary in order to make amateur training more

level-appropriate and realistic, instead of exclusively emulating the actions and training schemes that have proven successful for high-level athletes. Tactics for amateurs and professionals are different for two reasons: (a) in the amateur field, training should focus not on short-term results, but rather on the long-term process [Duricek 1992; Spamer, Hare 2001], and (b) actions that yield good results for professionals are not exactly the same as for amateurs, due to training methods and bout rules.

Ground-work was fundamental in the early years of the UFC, when submission occupied a prominent place in the different ways to obtain victory [Crossley 2015]. However, by 2014 it had become the least-common way to obtain victory, at just 6%. This may be due to the fact that in the early years of the UFC, athletes represented separate pre-existing martial arts styles [Schick *et al.* 2010], so many knew very little about how to fight on the ground, and could therefore barely fend off submission-oriented tactics. Nowadays, UFC athletes command a very comprehensive set of fighting techniques [Hu 2013], such that one rarely encounters a UFC athlete whose training has not included ground work to a greater or lesser extent. Thus, fighters are now much better prepared to defend themselves against submission-oriented tactics than they were in the early days of the sport.

However, have been not found any study comparing the results of, on the one hand, fighters competing in regional or national tournaments, and, on the other, those competing at high-level international tournaments. This type of study could reveal differences between fighters and strategies at different levels of competition. In the present paper, a video analysis has been used to evaluate the performance of several MMA athletes and the importance of grappling techniques in amateur and professional competitions. The subject of the study is to quantify the importance of takedowns and ground work in amateur competitions.

Methods

Sample

The present study analyzes 279 amateur male MMA matches fought in 2018, from the International Mixed Martial Arts Federation (IMMAF), the World Mixed Martial Arts Association (WMMAA) and the Spanish Federation of Olympic Wrestling and Associated Disciplines (FELODA). FELODA, the only Spanish combat sport federation that includes amateur MMA, is recognized by the Spanish Sports Council, and is also part of IMMAF, which is in turn supported by the UFC. In 2018 another important international amateur MMA federation, WMMAA, joined IMMAF. While these two federations independently held their own European Championships in 2018, that same year they unified, organizing the world championship together.

Competition rules are therefore similar for both federations. The criteria for inclusion in the study were that all bouts must have taken place in the Spanish, European or World Championships under the aegis of FELODA, WMMAA, or IMMAF, and, in addition, must have been shared online by the federations themselves via official links. Each of the four championships analyzed are named by geographical abbreviation (Spain: ES, Europe: EU, World: WO) and federation (Table 1).

Table 1. Analyzed championships (all held in 2018).

Championship	Code	Yr.	Bouts	Rounds		Source
				(Avg./Std. Dev.)		
Spanish Championship	ES	2018	38	74	(1.95/0.66)	https://www.youtube.com/watch?v=-KsIiT5pMYo
	FELODA					https://www.youtube.com/watch?v=b-3sqYap2fE
						https://www.youtube.com/watch?v=ktAiS_Qfnwk
European Championship	EU	2018	56	134	(2.37/0.86)	https://www.immaf.tv
European Championship	EU	2018	35	51	(1.46/0.56)	https://www.youtube.com/watch?v=eA3-ijVPutw
World Championship	WO	2018	150	355	(2.20/0.85)	https://www.immaf.tv
	IMMAF/ WMMAA					

Although in each championship the bouts had three rounds, the competition systems differed slightly. In ES FELODA and EU WMMAA, an athlete who wins the first two rounds wins the match, and the third round is cancelled. On the other hand, in EU IMMAF and WO IMMAF/WMMAA the third round is always fought. This difference in the rules does not alter the outcome of the match, but could change the nature of the win. An athlete which has won two rounds in EU IMMAF and WO IMMAF/WMMAA has already won the bout by decision, but in the third round he could perform a knockout or technical KO/TKO, or, less likely, perform a KO/TKO. This fact might be reflected in a higher number of bouts won by decision for ES FELODA and EU WMMAA than for EU IMMAF and WO IMMAF/WMMAA.

This study ensured anonymity and confidentiality by deleting the athletes' personal information. There are no ethical issues in analyzing or interpreting data obtained at public events, and the study was previously approved by the local Ethics and Research Committee.

Procedure

Each bout was divided into two well-differentiated stages: standing work and ground work. Each of these two stages involves several variables: time spent, techniques used, winner, and way to achieve victory. The techniques involved during the standing-work stage are strikes and takedowns (Table 2, Figure 1), while the ground-work



Figure 1. Some examples of the techniques used in this work to define the style of the fighters: A) Takedown without leg grip, using the hip, typical from judo-like styles; B) Takedown with leg grip, very popular in wrestling and jiu-jitsu; C) Ground and Pound, controlling and punching the opponent in the ground; and D) Submission using an elbow lock.

stage involves submissions (chokes and limb dislocations) and strikes, earning it the name “ground and pound”. All bouts begin with both athletes standing. Usually, after an exchange of strikes, fighters grab each other and attempt a throw. If the throw is successful, they enter the ground stage, which officially begins once a fighter has been on the ground for more than three seconds (according to the official United World Wrestling grappling rules). The time the athletes fight in each stage is recorded, and the more time spent on the ground, the greater the importance of ground grappling. Regarding the way to achieve victory, in the standing phase it is always achieved through striking, or KO/TKO, while for the ground-work phase it can be achieved by KO/TKO or by submission. When neither athlete is able to finish off their opponent before time is called, the referees decide the winner based on overall performance throughout the match.

Athletes from combat styles prioritizing stand-up grappling (i.e. judo, Olympic wrestling, sambo), holding, displacement, unbalancing and positioning have as their final objective to throw the opponent. Therefore, fighters who perform more takedowns have better stand-up grappling skills. For each bout we have analyzed each fighter’s number of takedowns, checking if their technique involved gripping the upper body or the legs. For a takedown to be considered valid, the fighter who attacks

Table 2. Technical variable analysis criteria based on the United World Wrestling Official grappling Rules and on the IMMAF official MMA rules.

TECHNICAL VARIABLES	ANALYSIS CRITERIA
Takedown	Throw the opponent, holding the position for at least three seconds.
Takedown without leg grip	Throw the opponent without gripping the leg, then hold the position on the ground for at least three seconds.
Takedown with leg grip	Throw the opponent by gripping the leg, then hold the position on the ground for at least three seconds.
METHODS TO WIN	
Decision	When time runs out and the referee decides the winner.
Stand-up TKO/KO	When one of the athletes cannot continue, either after falling unconscious, or because the referee stops the fight after the athlete has received one or several standing strikes.
Submission	When one of the athletes asks the referee to stop the fight or falls unconscious after a choke.
TKO/KO via “ground and pound”	When one of the athletes cannot continue after “ground and pound”, either after falling unconscious or because the referee stops the fight.

must control the position on the ground for at least 3 seconds. We have differentiated between takedowns with and without a leg grip. The most popular grappling style is judo, which currently bans takedowns by leg grip, meaning that judo fighters do not usually use leg grips when attacking. In this paper, takedowns are differentiated as being with or without a leg grip, in order to distinguish judo fighters from other grappling fighters who do perform takedowns by leg grip. Once on the ground, good ground grappling, which still includes striking, is essential to gain and maintain control over the position of the adversary. Once the opportunity arises, dominant fighters will then move in to secure a submission.

Statistical analysis

Descriptive statistical analysis was performed on the four tournaments, during the following year (2019). Bouts with time=0, in which one of the athletes did not show, were discarded. Two data models were generated, one for bouts and another for athletes. The bout model performed a descriptive statistical analysis of numerical variables (total bout time, standing time, ground time, total number of takedowns, takedowns with leg grip, takedowns with upper-body grip) and quantitative variables (bout ended in KO/TKO, KO/TKO while standing, KO/TKO on the ground by striking, KO/TKO on the ground by submission, winner performed most/least takedowns). The athlete model analyzed the data from each athlete in the 279 bouts, using the same variables as the bout model.

The data were analyzed with the software R (R_Core_Team, 2016) using a Freedman's ANOVA test was used to analyze repeated measurements. When differences were detected, the Tukey HSD test was used post hoc to identify specific differences between groups [Miller 1981; Yandell 1997]. The Pearson chi-square test was used to contrast dependence between certain variables. The significance level was set at $p < 0.05$.

Results

In relation to the time and the different phases of combat, Table 3 shows that for FELODA and EU WMMAA, average ground time was higher than standing time, while for EU IMMAF and WO WMMAA/IMMAF standing time was higher. The average number of rounds ranged from 1.5 to 2.4, with an average of 2.2.

Regarding how victory is achieved, in figure 2 is observed, at more than 70%, the most common way is by decision, followed by submission (17%), and finally by KO/TKO (12%), of which only 3.9% corresponds to stand-up KO/TKO, while 8.2% corresponds to KO/TKO via "ground and pound." These data show how the great

majority of bouts continue until time is up, and that it has become much more difficult to achieve a KO/TKO or a submission.

Table 3. Number of bouts, times and rounds.

	FELODA	EU WMMAA	EU IMMAF	WO WMMAA/IMMAF	TOTAL
Bouts analyzed	38	35	56	150	279
Total time	313.7 (151.8)	211.3 (116.5)	402.9 (181.6)	395.1 (189.8)	362.5 (186.2)
Standing time	145.5 (126.4)	85.8 (71.1)	248.8 (161.1)	211.4 (148.2)	194.2 (149.0)
Ground time	168.2 (139.3)	125.4 (88.3)	154.1 (138.6)	183.7 (138.8)	168.3 (134.4)
Rounds	1.9	1.5	2.4	2.4	2.2

While overall 70.6% of the bouts analyzed ended in decision, this percentage increases to 74.0% in the IMMAF world championship and drops to 62.9% in the European WMAA championship. Of the types of KO, the most frequent is KO on the ground. Regarding standing/ground-work times (Figure 3), two of the competitions had more standing than ground time, while the other two had more ground than standing time. In any case, the average for the four competitions shows a predominance of standing-work time (194.2 sec) over ground-work time (168.3 sec).

Average standing work is 194.2 sec for the 615 rounds analyzed, while for ground work average time is 168.3 s. Total average time is 362.5 sec (Figure 2).

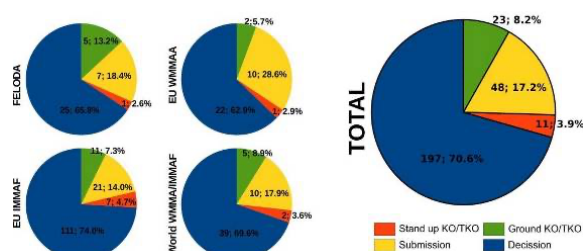


Figure 2. Quantification of methods to win the bout.

Figure 3 shows the comparison between the methods to win the bout and the time spent on standing/ground work, in this highlights the fact that for ground KO/TKO, submission and decision, ground work wins the bout just over half of the time. The obvious exception is stand-up KO/TKO, where the bout is almost always won through standing work. It must be taken into account that, as ground work on average takes less time (168.3 s) than standing work (194.2 s), ground work may be more decisive.

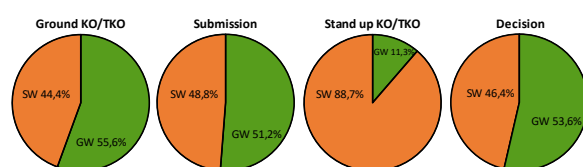


Figure 3. Standing-work (SW)/ground-work (GW) time vs. ways to win the bout.

To check the dependence between the variables – way of winning the fight and performing less, the same or more takedowns than the opponent – a chi-square Pearson test was carried out, with a p-value of <0.001 , which indicates that both variables are dependent. In other words, the method to win the bout is linked to how the takedowns are performed.

Regarding takedowns, the average number per bout is 2.4. By type of takedown, leg grips are significantly higher (1.7) than no-leg grips (0.7). As pointed out before, leg-grip takedowns are more likely to be performed by athletes with an Olympic wrestling/Brazilian jujitsu background, while takedowns without a leg grip most likely correspond to judo athletes. In figure 4 it can be seen that leg grips were carried out more often than no-leg grips, and proved more effective. As for the number of takedowns, winners on average clearly performed more takedowns than losers, as the most frequent situation was to win the fight and perform more takedowns than the opponent (69.9%). By contrast, the athlete with the least takedowns won the match in only 15.4% of fights, which indicates the difficulty of winning a bout while achieving fewer takedowns than one's opponent. Finally, in 14.7% of bouts the athletes tied in takedowns. Similarly, when comparing the number of takedowns by each athlete, we find that winners tend to perform more takedowns than losers, at an average of 1.8 vs. 0.6 per match. This difference is true of takedowns both with and without leg grips. In this way, achieving a greater number of takedowns is a key factor in winning an amateur MMA bout, with a confidence level of 99.9% (p-value <0.0001).

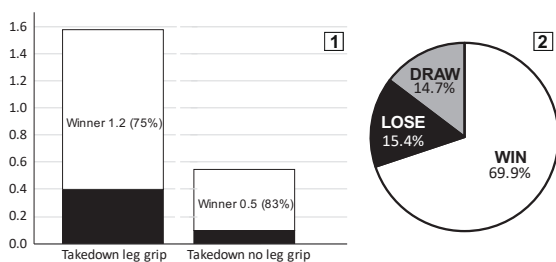


Figure 4. 1): Average overall takedowns per bout (black), and average takedowns performed by the winner (white). 2): Percentages for performing the most takedowns and winning (white), losing (black) and tying (grey).

However, when analyzing the average time spent fighting on the ground against who wins the fight (winner in takedowns or loser in takedowns), the percentages are very similar (51.2% for winner in takedowns and 48.8% for loser in takedowns). For bouts ending in a tie, the average is 21.1%. This means that an athlete who pulls off a throw will not necessarily control the ground work, but when both athletes are equally skilled at throwing, ground work is reduced, and it is the standing work that proves decisive. Thus, when comparing the total percentages for the various winning methods, we find that

in stand-up KO/TKO wins, both athletes frequently tie in number of takedowns; however, in submission and KO/TKO via “ground and pound,” the winner usually performs more takedowns than the loser.

In figure 4 is observed that when comparing the average number of takedowns made by the winner of the bout and the average number of rounds per bout, the data are quite similar in the Spanish Championship, European Championship WMAA and World Championship, insofar as in all three cases the mean number of takedowns is slightly lower than the average number of rounds.

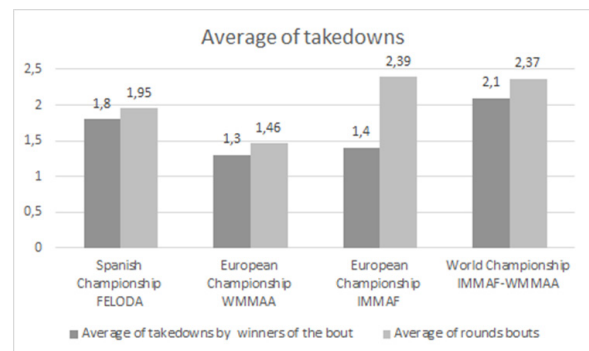


Figure 5. Average number of takedowns by winner and by championship.

In these three championships, the winner of the bout performs an average of approximately one takedown per round. The average takedowns by the bout winner is 1.8, of which 1.3 are achieved with a leg grip and 0.5 are not. If we look at each particular championship, in the Spanish Championship the average number of no-leg-grip takedowns is 0.3, while in the World Championship it is double: 0.6. The European championships, in turn, have an intermediate average of 0.5 and 0.4.

Discussion

Comparing our data with those from Crossley [2015], we find a difference between professionals and amateurs: among amateurs, submission is the most common way to end a bout before time is called, representing 17% of the total, while among professionals submission accounts for just 6%.

When comparing the Spanish championship with the world championship. We observe how the percentage of fights won by decision increases, being higher in the world championship. However, the opposite occurs with the bouts that are won via submission, which decrease in the world championship. This points to a trend whereby the higher the level of the athletes, the more comprehensive their skill set across the different phases of the bout. As a result, they are increasingly able to avoid submissions and KO/TKOs, meaning that more bouts end in the hands of the judges.

On the other hand, none of the aforementioned studies differentiates between KO/TKOs that occur while standing vs. on the ground. This is important, since in bouts where the KO/TKO takes place on the ground, the ground grappling proves crucial in order to secure a position amid effective strikes. We must bear in mind that in MMA there are strikes, which is a fundamental difference with respect to other ground-based fighting styles such as Brazilian jujitsu. Even so, although an effective strike can certainly injure one's opponent, thereby helping to secure and retain a position on the ground, our analysis indicates that it is grappling that is particularly influential in MMA bouts. Specifically, when differentiating the types of KO/TKO, we find that KO/TKO via "ground and pound" makes up 8% of wins, whereas stand-up KO/TKO barely reaches 4%. If we take into account only bouts ending before time, and we add fights won by submission and by KO/TKO via "ground and pound," we find that together they make up 86.6%. What this means is that ground work proves decisive in nearly 90% of matches that finish before time is called.

Ground work also proves important in relation to bout time. According to the data obtained, nearly half of the average amateur MMA bout – 46% – takes place on the ground, and as such fighters cannot overlook the need to dominate the fight in this phase. We have already discussed the importance of ground-work in bouts that end with submission and KO/TKO. However, with respect to the other two ways of obtaining victory, i.e. decision and stand-up KO/TKO, a significant difference is observed with respect to time spent on the ground, whereby in matches that end with an arbitration decision we find more time spent in ground work. All these data reveal that in 96% of bouts – those where the victory is achieved by submission, by KO/TKO via "ground and pound," and by decision – the ground work weighs heavily on the outcome, and must be taken into account when training amateur MMA athletes.

As for stand-up grappling, data indicate that the most commonly used takedowns in amateur MMA are those in which one or two legs are gripped. Although in judo, leg-grip takedowns are prohibited in competition, in freestyle wrestling they are not only allowed, but, according to multiple studies, are the main technical focus when developing attack efficacy [González *et al.* 2012; Tunnemann 2011]. In this way, similarities are observed regarding the stand-up grappling in freestyle wrestling and in amateur MMA, because in both they successfully use leg-grip takedowns over other types of takedowns.

When comparing the average number of takedowns made by the winner of the bout and the average number of rounds per bout, in the Spanish Championship, European Championship WMMAA and World Championship, an increase in the number of takedowns is observed in international championships, compared to national ones. Data could indicate that the higher the level, the more an athlete is familiar with and performs

a greater variety of takedowns.

The importance of stand-up grappling is illustrated by the fact that in practically 7 out of 10 of amateur MMA matches the winning athlete was also the one who had performed the most takedowns. This result supports the theory that takedowns are decisive for victory in MMA. Along these same lines, Kirk *et al.* [2015], after recording different variables in MMA bouts, notes that the only difference between winners and losers is the number of successful takedowns, and Miarka *et al.* [2017] list takedowns as one of the most significant variables in winning bouts, along with landing head strikes, keeping distance, and making offensive passes. Takedowns are also on James *et al.* [2017]'s list of decisive variables for victory in MMA, which include significant ground strikes, and landed and significant strike accuracy. Thus, our results, which are in consonance with results obtained by other researchers who have studied professional MMA, clearly reveal that in amateur MMA takedowns are a decisive factor in achieving victory.

When relating the time spent in ground work to whether an athlete wins, loses or ties in takedowns, the data indicate that ground time is significantly shorter when the athletes tie in takedowns, as opposed to when either opponent wins. In this way, athletes who seek to strike while standing must also have a command of stand-up grappling on par with that of their opponent. Thus, we find that parity in stand-up grappling ability is an effective way to avoid ground work. These data therefore bring to light an important consideration: that athletes with a good command of stand-up grappling can decide whether they want to fight on the ground or not. This is because dominance in stand-up grappling serves not only to throw and thereby move the fight to the ground, but also to avoid takedowns and keep the fight up at standing level; in short, to decide the overall strategy of the bout. This ability to control the passage from standing to ground work is key, since a good stand-up striker's skills will go to waste on the ground, while expert ground grapplers will likewise not be able to showcase their skills if they are unable to take down their opponent.

We also compared how matches were won, whether an athlete achieved more or fewer takedowns than their opponent. A correspondence analysis yielded a clear association between performing more takedowns than the opponent and winning by decision – the most common outcome, at 70%. To perform a takedown, athletes must master gripping during the clinch phase [Kruyning, de Jong 2014]; in addition, the athlete who performs the takedown begins with an advantageous position on the ground. This explains why athletes with more takedowns are able to dominate the bout more easily and win by decision.

On the other hand, victory by standing KO is associated with both fighters making an equal number of takedowns and, in addition, in such cases standing time was found to be significantly longer. This extra standing time means that there are more opportunities to perform a stand-up KO/TKO.

Finally, performing fewer takedowns than the opponent and winning the fight accounts for 15% of the total, and is associated with winning by submission. This indicates that in an amateur MMA fight, once an athlete is thrown to the ground their best option to win is by forcing their opponent into submission. Thus, even when thrown to the ground, athletes who are experts in ground work can still take advantage of the phase of the bout where they excel.

Conclusions

The analysis of the results obtained indicates that in order to achieve victory in amateur MMA one must be adept at both stand-up grappling and ground-work. To dominate the stand-up fight by performing more takedowns that one's rival is a decisive factor to win the bout, with leg-grip takedowns being the most common. Ground-work must occupy an important place in the training of an amateur MMA athlete because, in the matches studied here, nearly half of the time elapsed occurs on the ground. The fights that end by decision are the ones with the longest ground-work time; much longer, in fact, those ending in a stand-up KO/TKO. Likewise, fights where athletes tie in number of takedowns have significantly less ground time than those in which one of the two makes more takedowns than the other. Ground work is especially important in fights that end before time is called, the great majority of which end in submission or KO/TKO via “ground and pound.”

In summary, our data associate winning by decision with making the most takedowns, winning by stand-up KO with tying in takedowns, and winning by submission with making the least takedowns. These data should be taken into account by amateur MMA coaches to guide their training strategies based on each athlete's particular strengths and weaknesses.

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Badanie efektywności: walka w stójce vs. walka w parterze w amatorskich walkach MMA

Słowa kluczowe: obalenie (*takedown*), mieszane sztuki walki, brazylijskie *jiujitsu*, sporty walki, badania czasu i ruchu

Streszczenie

Tło. Zawodnicy MMA dzielą się na dwie grupy: uderzaczy (*striker*) i parterowców (*grappler*). Przedmiotem badań było ilościowe określenie znaczenia obalenia przeciwnika (*takedown*) i walki w parterze w zawodach amatorskich. Metody. W niniejszym badaniu przeanalizowano 279 amatorskich walk MMA mężczyzn stoczonych w 2018 roku, stosując test *Tukey Honest Significance Differences* (Tukey HSD) i kwantyfikując zależności między różnymi umiejętnościami walki i sposobem wygrywania walk.

Wyniki i dyskusja. Zwycięzcy walk MMA, średnio znacząco częściej sprowadzali przeciwnika do parteru (*takedown*) niż przegrani, gdyż najczęstszą sytuacją było wygranie walki i wykonanie więcej obaleń niż przeciwnik (69,9%). Zaobserwowano, że po wykonaniu testu *chi kwadrat Pearsona*, przy wartości $p < 0,001$, zależność pomiędzy zmiennymi – sposobem wygrania walki i wykonaniem mniejszej, takiej samej lub większej liczby obaleń niż przeciwnik. Ponadto, gdy walki kończą się przez decyzję sędziów, poddanie lub nokaut (*ground KO/TKO*), zawodnicy spędzają więcej czasu walcząc w parterze niż w stójce. Jednakże, gdy walka jest wygrana przez nokaut *KO/TKO* w pozycji stojącej, to większość pojedynku odbywa się w stójce.

Wnioski. Wyniki autorów ujawniają, że zawodnicy mają największe szanse na wygranie pojedynku, gdy stosują rzuty w stójce, pokonując przeciwnika. Z drugiej strony, gdy zwycięstwa są przez nokaut *KO/TKO*, obaj zawodnicy często remisują w liczbie *takedownów*; jednak, gdy zwycięstwo następuje przez poddanie się i *KO/TKO* przez rozłożenie przeciwnika na łopatki, zwycięzca ma tendencję do wykonywania większej liczby obaleń przeciwnika niż przegrany.