UNIVERSIDADE Ð
COIMBRA

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TIME MOTION ANALYSIS DURING FIGHTS IN MIXED MARTIAL ARTS MATCHES

Dissertation submitted to the Faculty of Sport Sciences and Physical Education of the University of Coimbra, for the degree of Master in Biokinetics

September 2019

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Coimbra, September 2019

Gentili, G. (2019). TIME MOTION ANALYSIS DURING FIGHTS IN MIXED MARTIAL ARTS MATCHES: Dissertation for the degree of Master in Biokinetics. University of Coimbra, Coimbra, Portugal.

AKNOWLEDGMENT

There are a lot of people I would like to thank before starting to talk about this work.

First of all, my lovely fiancee that allowed me to keep going and never give up even in my dark moments of dejection that sometimes this kind of works can lead towards; to my parents and my family that despite many difficulties (everyone says how expansive can be to study abroad) allow me to got this degree; a special thanks to my teacher, coordinator and friend Ana Maria Faro, that introduce me the University of Coimbra and the awesome world of the academic work, that despite the distance was always by my side and strongly believes in me; Of course I can say the same of my teacher counter-rapporteur Beatriz Gomes, that promptly gave me much suggests as possible when I needed them more. Last but not for the importance that I want to thank is my friend Matteo which I started and finished this fantastic adventure like students togheter, without him some days would have been strongly difficult.

This experience in this university opened my eyes towards a new world of discoveries and comparisons, Coimbra has this kind of magic.

I would like to keep going on my work of researcher as I strongly believed that there must not be limitations on knowledge and learning and I hope this work can be useful for someone in the future days and in the knowledge of my discipline MMA.

Never stop to study, never stop to learn and never stop to be curious.

ABSTRACT

INTRODUCTION: Mixed martial arts is a modern combat sport held in an octagonal cage, where two fighters use to fight each other through standing (striking) and grounding (grappling) fighting style. The aim of this study was to provide a knowledge on tactical aspects of mixed martial arts to find out which of the two fighting style is more used, and dividing the fighting area in three parts (centre, side and wall) in which part of the cage the match is more focused and in which of the two fighting style. **METHODS:** A selection of 16 amateur matches (n=16) with 3 rounds each one of the duration of 3 minutes, were analysed through a time motion analysis. This study included only matches won by judges' decision, excluding every fight ended before the limit. 4 matches were removed from the analysis. All the athletes (n=32) were males, born in Portugal and members of the "Federação Portuguesa de Artes Marciais Mistas" o FPAMM, the national Portuguese federation of mixed martial arts, that is represented by the "International Mixed Martial Arts Federation" or IMMAF, the highest competition level of amateur mixed martial arts fighters in the world; they were born in Portugal and coming from local mixed martial arts team, aged 26.13 ± 1.68 years, with an MMA experience of 4.84 ± 2.95 years, and in a weight category between 61 and 77 kg. A descriptive analysis was applied for every chrono-variable and a comparison of the means through a t student test between striking and grappling for every of those chrono-variable was done. **RESULTS**: data analysed showed in round one and two, no significant difference was found ($p \geq 0.05$) between striking and grappling style at the centre zone, but a very significant difference ($p \leq 0.001$) between the fighting style in third round was found, with a preference in striking style. Anyway, a very significant difference ($p \leq 0.001$) was present in round one, two and three at the side and wall zone between striking and grappling, with a predominance in grappling style. A significant difference ($p \leq 0.05$) was found between the comparison of striking and grappling style in round one, two and three, with a predominance in grappling style. **DISCUSSION:** The analysis done lead to deduce that in a mixed martial arts fight, grappling style is predominant in every one of the three rounds and in wall and side zone, except for the third round, where the centre zone is predominated by striking style positions. **CONCLUSION**: This research can provide technical and tactical aspects of mixed martial arts fight, that as a new born combat sport is in need of more studies/knowledge as well as a multidimensional profile of the athletes still need to be completed.

Keywords: Time motion analysis, video analysis, mixed martial arts, grappling, striking, cage zones, fights.

RESUMO

INTRODUÇÃO: As artes marciais mistas são um desporte de combate moderno realizado numa gaiola octogonal, onde dois lutadores lutam utilizando diferentes estilos de luta: em pé (striking) e aterrar (grappling). O objetivo deste estudo foi fornecer um conhecimento sobre os aspectos táticos das artes marciais mistas para descobrir qual dos dois estilos de luta é mais usado, e dividir a área de combate em três partes (centro, lado e parede) em que parte do gaiola o combate é mais focado e em qual dos dois estilo de luta. **MÉTODOS:** Uma seleção de 16 combates (n = 16) com 3 rounds, cada uma com a duração de 3 minutos, foi analisada através de um sistema time motion analysis. Este estudo incluiu sò os combates vencidos pela decisão dos juízes, excluindo todas as lutas terminadas antes do limite de tempo. 4 combates foram removidos da análise. Todos os atletas (n = 32) eram do sexo masculino, nascidos em Portugal e membros da Federação Portuguesa de Artes Marciais Mistas, a federação nacional portuguesa de artes marciais mistas, representada pela "Federação Internacional de Artes Marciais Mistas" ou IMMAF. , o mais alto nível de competição de lutadores amadores de artes marciais mistas no mundo; Todos os subjeitos nasceram em Portugal e provinham de uma equipa local de artes marciais mistas com uma idade de 26.13 ± 1.68 anos , e uma experienca nos MMA de 4.84 ± 2.95 anos, numa categoria de peso entre 61 e 77 kg. Uma análise statistica descritiva foi aplicada para cada variável-cronograma e uma comparação das médias das diferente variaveis foi comparada através um teste t student. O grau de significancia foi estabelecido para $p \leq 0,05$. **RESULTADOS:** os dados analisados mostraram, no 1ª e 2ª round, que não houve diferença significativa ($p \geq 0,05$) entre o estilo de striking e grappling na zona central, mas uma diferença muito significativa ($p \leq 0,001$) entre o estilo de luta no terceiro round, com uma preferência em estilo do striking. De qualquer forma, uma diferença muito significativa ($p \leq 0,001$) estava presente na primeira, segunda e terceira fase na zona lateral e na parede entre striking e grappling, com predomínio no estilo de grappling. Uma diferença significativa ($p \leq 0,05$) foi encontrada entre a comparação entre estilo de striking e de grappling na primeira, segunda e terceira séries, com predomínio no estilo de grappling. **DISCUSSÃO:** A análise feita leva a deduzir que em uma luta de artes marciais mistas, o estilo de luta em grappling é predominante em cada um dos três rounds e em todas as zonas, exceto no terceiro round, onde o estilo predominante foi o estile de striking. **CONCLUSÃO:** Esta pesquisa comtribui com um aspecto técnico e tático de um lutador de artes marciais mistas, mas sendo um novo desporto de combate necessita de mais estudos e um perfil multidimensional de um atleta ainda precisa ser completado, por isso mais pesquisas por meio de análise de vídeo devem ser feitas.

Palavras-chave: Análise de movimento no tempo, análise de vídeo, artes marciais mistas, luta, ataque, zonas de gaiola, lutas.

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ABBREVIATION LIST:

% - Percentage

CI – Confidence Interval

FPAMM - Federação Portuguesa de Artes Marciais Mistas

GPS - Global Positioning System

IMMAF - International Mixed Martial Arts federation

M&P analysis - Match & performance analysis

Max - Maximum

Min - Minimum

MMA - Mixed Martial Arts

s - Seconds

SD – Standard deviation

SE – Standard error

VO$_2$ max - Maximal oxygen uptake

1 - INTRODUCTION

Mixed Martial Arts (abbreviated in MMA) is a modern extreme fight sport. The evolution of the ancients' martial art styles mixed all together in a unique discipline. It incorporates all the percussion fighting styles (like boxing, kickboxing, karate...) with all the ground fighting styles (like judo, wrestling, sambo...). The most important and significant world federation is the International MMA Federation (IMMAF) which takes care about this sport all over the world, amateur and professional. Athletes fight into an octagonal cage that must be circular or have at least eight equal sides and must be no smaller than 6.096 m x 6.96 m and no larger than 9.75 m x 9.75 m. Being a combat sport it imposes fixed times fight subdivided into rounds, where fighters use to fight in weight – from Straw weight with lee than 52.2 kg to Heavyweight with more than 120.2 kg - and age – juniors and seniors - category.

- Straw-weight under 52.1631 kg
- Flyweight: limit 56.7 kg
- Bantamweight: limit 62 kg
- Featherweight: limit 65.7 kg
- Lightweight: limit 70.3 kg
- Welterweight: limit 77 kg
- Middleweight: limit 84 kg
- Light Heavyweight: limit 93 kg
- Heavyweight: limit 120 kg
- Super Heavyweight: more than 120 kg

In amateur rules, fighters use to fight into 3 rounds of 3 min; only professional use to fight more than 3 minutes (IMMAF 2017). The two fighters start their combat in a standing position, and every kind of attack is allowed. The standing fighting style is called "striking", id est. technique from the percussions sports like karate, boxing, taekwondo… it means punches, hits with elbows, knee, and kicks. One of the two athletes can take the other one and fling him to the ground with techniques - trying to catch the leg of the opponent for example – that come from judo, wrestling, etc., and continue the fight on the ground, bringing punches or looking for a finalization – a technique of submission that lead the opponent to draw –; this part of the fight is called "grappling". Matches can be won by a knockdown - caused by a kicks or punches -, submission – a technique like a joint lever or a strangling that brings the opponent to draw –, or by a ground and pound – when someone starts to hit the other into the ground forcing him to draw, or the arbiter to stop the fight (IMMAF, 2018). In Portugal, the predominant federation is the FPAMM (Federação Portuguesa de Artes Marciais Mistas) inside the IMMAF (International MMA Federation) (CAPMMA.org, 2018). Due to the young nature of this "new born" sport, a great lack is still present, both in scientific literature and research (Bishop, La Bounty and Devlin, 2013). Anyway, the new discoveries in sports sciences led the physical preparation into

new levels and knowledge, that is why, through the modern knowledge, the possibility of develop are huge (Kim, Andrew and Greenwell, 2009). Being an individual combat sport, physical training is strictly personal and needs to be adapted to each athlete who possesses his own characteristics, like every kind of combat situational sport has demonstrated (Andreato et al., 2013; Ashker, 2011). Technical and tactical preparation depends on the athlete fighting school's provenience and from his/her history of fighting. Every academy or athlete has its own personal combat style (Franchini et al., 2008).

1.1 - The Video Analysis

"Video analysis" is the maximal expression of the sports analysis (O'Donoghue, 2008); studying the athlete attitude, in every discipline is necessary to improve the individual or the team performance. During the ages this analysis has been improved, in now-days, with the modern systems it is possible to film and analyse athletes' actions within a computer (Tong, Liu and Lu, 2009; Italian Olympic committee, 2018). Match & performance (M&P) analysis is a process that refers to the analysis of the match and to the performance, which has its own methods, rules, and protocols. Match analysis is a kind of instrument inside the match and performance analysis in the sport. When in scientific literature is talked about M&P analysis is common to find not only the using of the videos but also inertial GPS (like accelerometers) and not inertial (like heart rate monitor, lactate monitor, and motion capture) (Hughes and Franks, 1997; H. Sarmento et al. 2014). Video analysis is so an instrument of M&P analysis and in particular, it is possible to divide it into two different kinds of analysis: notational analysis, and time-motion analysis. The notational analysis consists of writing events happened during the competition or training, and the analysis can be during or after the performance. The main worker during this process is the video analyst, that prepare and summarize the observation of the events (Gabbett and Mulvey, 2008; Spencer et al., 2004). Time-motion analysis is the valuation of cinematic variations (how much distance was done, velocity, acceleration, the space of the competition) of athletes' physical performance and it uses both of video tracking and sometimes GPS. Here, the competence of the analyst must be impeccable during data analysis (Ben Abdelkrim et al., 2007). Data analysis is the process' identification of mathematical and statistical analysis of data collected in order to be summarized and having answers despite the beginning questions. Descriptive and inferential statistic are the main instrument of this process and competence in methodology, scientific research and the ability to use statistical analysis are crucial for the analyst who works on this branch of sporting analysis.

1.2 - The Video Analysis in MMA

Sacripanti describes match analysis the key of the optimal performance for the trainer and his/her team (Sacripanti et al. 2007). Considering that MMA is the fusion of several combat sports, from the video analysis of other fighting and situational sports like judo (Marcon et al., 2010), fencing (Wylde, Tan and O'Donoghue, 2013), boxing (Davis and Beneke, 2010) and taekwondo (Tornello et al., 2013), that it is possible to deduce a lot of information that are possible to associate with MMA. An important result was obtained by Del Vecchio (Coswig, Ramos and Del Vecchio, 2016; Del Vecchio, Hirata, and Franchini, 2011) who analysed the recording of MMA fights using a camera positioned at the last row of the bleachers where the event was held, emphasizing the importance of the time-motion analysis in pause and effort during a fight, and its difference between the weight categories. In fact, his research is cited in another one that is focused on time motion analysis in judo and Brazilian ju-jitsu fights (Coswig et al. 2018) were the aim of the study was to predict the technical-tactical and time-motion profile of the athletes. Sacripanti describes the entire match analysis a way to find out three important characters inside the profile of a situational sports' athlete (Sacripanti et al. 2007): It is important to denote how to analyze a competition or training is crucial to obtain more profiles of the athlete. This means that filming a single athlete or more athletes during a competition, the trainer will be able to see a different aspect of the athlete (Sacripanti et al. 2007):

1) One of the firsts aspects of an athlete or a team that is possible to analyze through video analysis is physical performance, or better the physical aspects. Using the video analysis of a competition or a simulated one, a specific training or a simple daily training it is possible to scan the physical performance of a single athlete or an entire-time (Del Vecchio, Hirata & Franchini, 2011; Gastin, 2001). It is possible for example, to analyze the athlete's strength: seeing if he won or lost a resistance against the opponent (Kraemer, Vescovi, and Dixon, 2004; James, Kelly and Beckman, 2013); if the athlete has good stamina: evaluating active and passive phases and their intensity it is possible to see when the fighter uses them to rest or not (Del Vecchio, Hirata & Franchini, 2011); evaluating how fasts are the actions of the athlete: if it was too slow or fast enough in order to do a movement or a stroke (Silmani et al., 2017; Šiška and Brodáni, 2016; Said El Ashker, 2011; Piorkowski, Lees, and Barton, 2011; Rodrigues Silva et al., 2011; Ouergui, 2014). All of these are important pieces of information that allow creating an efficient physiological profile of an MMA fighter (strength, stamina, power...).

2) Another aspect described by Sacripanti is the technical analysis (Sacripanti et al. 2007). Through the video analysis of a competition or a training, it is possible to evaluate some aspect of the technical movement of the discipline, as the right execution of a punch or a wrestling movement adapted in some situation or better to study the fighting style of an athlete and looking for his weaker point (if he is weaker in striking or grappling for example) is a perspective of the video-analysis for a trainer (Ashker, 2011). An example of technical analysis in MMA is the evaluation of the predominant fighting style of an athlete, for example to see how many fighters use to fight in standing position or in ground position, and which techniques are most used, as kicks or punches (Buse, 2006; Sheard, 2004).

3) The last aspect described by Sacripanti is the opportunity of analyzing the strategy of the own team or athlete through the study of the tactical analysis. Aim of this phase of the study is that through the observation of sporting performances, it is possible to improve the tactic and the strategy that will be done on the competition. Moreover, the tactical study of a single or a team opponent allows to set up an efficient strategy to apply against. Sacripanti describes some particular phases that denote how is important to study them: attack, defense, counter-attack, and keeping of the advantages taken, are crucial phases that need to be evaluated during a tactical video analysis (Sacripanti et al. 2007). A tactical analysis in MMA can lead a study to define for example, how much time an athlete uses to stay under effort and how much time uses in recover phases (Del Vecchio, Hirata & Franchini, 2011); another tactical study in MMA can be which kind of fighting an athlete use to apply more, it is in standing or ground position (Gastin, 2001).

The aim of this study was to define the more used combat style in MMA: if it was striking (in standing position) or grappling (in-ground position). Also to determine if there could be a correlation between fighting style and cage's zones, dividing it into three zones: center, side, and wall. It was intended to study the tactical profile of the MMA athlete, knowing which fighting style and in which part of the competition field each one is more used allowing to every MMA coach to increase the knowledge about the tactical aspects of this sport (where a fight is usually more fought in a competition). Moreover, this kind of analysis can be applied to a single athlete and consequently to analyze his fighting style (how many time does he spend on the center, side, and wall?). Until now, the tactical and most of the technical aspects of an MMA athlete are still unknown.

2 - METHODS

2.1 - Samples

Thirty-two athletes (n=32) divided per 16 matches (n=16) were analysed during a regional Portuguese tournament were analysed (aged 26.13 ± 1.68 years; experience in MMA 4.84 ± 2.95 years) with the weight categories between 61 and 77 kg (the bodyweight nearby the average weight of a Portuguese person, Walpole et al., 2012). Athletes analysed were only males and born in Portugal. Written informed consent was obtained from all participants after verbal and written explanations of the experimental design.

Of the 16 matches, only 12 were considered because didn't ended before the limit. All the original data after they were converted in pergentage time are in appendix a) for the round 1, appendix b) for the round 2 and appendix c) for the round 3.

2.2 - Video Analysis and study design

During a regional tournament held in Porto (Portugal) a selection of 32 athletes (n=32) were analysed during MMA fights. During the competition, a video camera (Video camera sportive G-Eye 900 4K and Full HD) was positioned on a height of 3 meters and a distance of 2 meters from the centre of the cage, in order to do not disturb the competition, on a specific stick (Braccio telescopic co-nect per videocamera Sportiva) adequately fix. The video recording started 5 minutes before the first match and ended 5 minutes after the last one. In order to analyse the action phases of the athletes, before the video recording, cage's
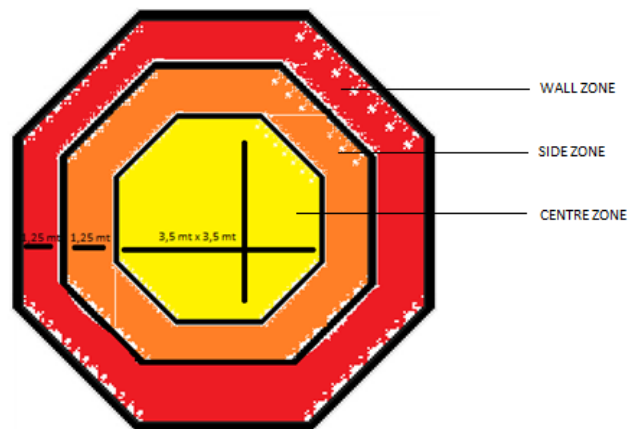
Figure 1. Model of the cage and zones

ground was marked by insulating scotch tape (ATCO); starting from the center, a measure of 3.5 meters' to the wall was measured. After that, the rest was divided per 2, obtaining 1,25 meters. After the measures were taken, the field of the cage was marked with the tape; the lines that divided the zones in three part, id est the centre, the side and the wall, were required to have a clear vision of the movements of the athletes during the video-analysis. Consequently, after the analysis of the video tapes, a correlation of the time athletes spent fighting in standing or grappling position between the zones of the cage was done. The seconds of the fights that athletes spent during their fighting phases, were collected thanks to the function of the "slow motion capture" present in the software of video analysis called "Longo Match". The process of the study was the following: collecting how many times (in seconds) athletes used to fight in standing or ground position at the

centre, at the side and at the wall zone. A problem of the analysis that occurred during the studying process was that usually athletes use some phases both in standing and ground position to recover. To avoid this problem, all the standing phases were considered "striking phases" and all the ground phases were considered "grappling phases". If an athlete was on a standing position and the other was in a ground position, it was considered a "striking phase".

2.3 - Data analysis

Data were collected in a table done specifically for this work (Table 2), were the total time in centre, side, wall, number of the fight, weight of the two athletes and result (win by decision or before the limit). For every of the three rounds, time in seconds were reported on the model table (Table 2), reporting the total times of the zones divided per striking and grappling

ROUND 1/2/3

			Striking				Grappling			
Weight (Kg)	Fight n°	Result	Centre (s)	Side (s)	Wall (s)	Total Striking time (s)	Centre (s)	Side (s)	Wall (s)	Total Grappling (s)
x	x	won by …	X	X	X	X	X	X	X	X

Figure 2. Example table for data collection

Having all the data in seconds, numbers were transformed in percentage. The transformation of the seconds in percentage times was done considering that: an entire round was 180 seconds, so 180 seconds = 100%. The operation was applied for every round for every zone of the cage, using a table like figure 3.

ROUND 1/2/3

Striking				Grappling			
Centre (s)	Side (s)	Wall (s)	Total Striking time (s)	Centre (s)	Side (s)	Wall (s)	Total Grappling (s)
X	X	X	X	X	X	X	X
Centre (%)	Side (%)	Wall (%)	Total Striking time (%)	Centre (%)	Side (%)	Wall (%)	Total Grappling time (%)
X	X	X	X	X	X	X	X

Figure 3. Example table for the transformation of data from seconds to percentage time

2.4 - Statistical analysis

Once data analysis was performed, an overview of every single round was applied describing the times in seconds of grappling and striking. In order to evaluate which time in a zone was predominant and in which fighting style, a descriptive statistic of the percentage times of striking and grappling (previously calculated), was performed for each variable (total time in striking and grappling phases in centre, side and wall zone), analysing the range (minimum and maximum), the mean (value, standard error (SE), 95% Confidence Interval 95% (CI) and standard deviation (SD). Once obtained the descriptive statistic of each data, a comparison of the mean with t-student was done in order to find out a significant difference between the variables. The comparison was made for: mean of striking compared with grappling at the centre, side and wall zone. The data compared were the following:

    For the round 1, 2 and 3:

- Comparison of the means for striking and grappling time (%) at the centre zone
- Comparison of the means for striking and grappling time (%) at the side zone
- Comparison of the means for striking and grappling time (%) at the wall zone

    The P value for a statistical significance, mean, Confidence interval of 95% (Cl), standard deviation (SD) and the standard error of the mean (SEM) were calculated through the t-student test; All the calculations were made using the SPSS version 22 (IBM SPSS Statistics, Armonk, NY, IBM Corp).

3 - RESULTS AND DISCUSSION

3.1 - Age and training experience

Table 1 shows the descriptive statistics for the chrono-variables of the fighters observed in the study (n=36). The chronological age averaged 26.13 ±1.68 years. The fighters have a training experience from 2 to 12 years with a mean value of 4.84±2.95 years.

Table 1. Descriptive statistic for chrono-variables

		Range		Mean		Standard Deviation
		Minimum	Maximum	value	(95% CI)	
Chronological age	Years	24	29	26.13	(25.52 to 26.73)	1.68
Training experience	Years	2	12	4.84	(3.78 to 5.91)	2.95

3.2 - Analysis of the round 1

In round one, 3 zones were analysed with their time divided in striking and grappling; a total of 24 time (N=24) of 12 matches were analysed for the centre, side and the wall zone; after that, a comparison between times in striking and grappling were compared in every of three zone. Table 2 shows the values of the first round for every zone analysed. for the centre zone, striking and grappling were analysed with a range of time minimum of 4 seconds and a maximum of 110 seconds. The mean time was 37.71 seconds and the standard deviation was of 28.07 seconds. The same analysis was applied on the side zone with a range of time minimum of 1 seconds and a maximum of 118 seconds. The mean time was of 25.33 seconds and the standard deviation was of 29.49 seconds; At the wall zone, a range of time minimum of 0 seconds and a maximum of 111 seconds were found. The mean time was 28.96 seconds and the standard deviation was of 37.89 seconds.

Table 2. Descriptive statistics for the time in the zones (N=72) of the cage in round 1

		Range		Mean		St. D. (s)
	N° of Times	Minimum time (s)	Maximum time (s)	Value (s)	95% Cl	
Centre	24	4	110	37.71	(23.86 to 47.56)	28.07
Side	24	1	119	25.33	(12.88 to 37.79)	29.49
Wall	24	0	111	28.96	(12.96 to 44.96)	37.89

SE (standard error); CI (confidence interval); St. D. (Standard deviation)

3.3 - Analysis of the centre zone in round 1

Table 3 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the centre zone of the cage in round 1. Data in striking showed a minimum time of 8.3% and a maximum time of 89.2%, with a mean of 48.83% spent during striking phases at the centre zone, with a standard deviation (SD) of 25.62% and a Confidence Interval (CI) between 32.56 to 65.1. Data in grappling showed a minimum time of 10.8% and a maximum time of 91.7%, with a mean of 51.18% spent during grappling phases at the centre zone, with a standard deviation (SD) of 25.62 and a Confidence Interval (CI) between 34.91 to 67.45. Table 4 shows a comparison of the mean time spent in striking and grappling phases still at the centre zone in round 1 done with a t student test. No differences ($p \geq 0.05$) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis.

Table 3. Descriptive statistic of the first round at centre zone

Parameter	Striking Value	Grappling Value
Mean (%)	48.83	51.18
SD (%)	25.62	25.62
N	12	12
95% CI	32.56 to 65.1	34.91 to 67.45
Minimum (%)	8.3	10.8
Maximum (%)	89.2	91.7

SD (Standard Deviation); CI (Confidence Interval)

Table 4. Comparison between striking times and grappling times at centre in Round 1

Two Tailed P value	0.8242
CI difference	From -24.04 to 19.34

CI (Confidence Interval)

3.4 - Analysis of the side zone in round 1

Table 5 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the side zone of the cage in round 1. Data in striking showed a minimum time of 1% and a maximum time of 90%, with a mean of 30.26% spent during striking phases at the side zone, with a standard deviation (SD) of 31.38 and a Confidence Interval (CI) between 10.33 to 50.2. Data in grappling showed a minimum time of 9.5% and a maximum time of 99%, with a mean of 69.76% spent during grappling phases at the side zone, with a standard deviation (SD) of 35.31 and a Confidence Interval (CI) between 49.82 to 89.69. Table 6 shows a comparison of the mean time spent in striking and grappling phases still at the side zone in round 1 done with a t student test. Highly statistically significant differences ($p<0.05$) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between -66.06 to -12.93.

Table 5. Descriptive statistic of the first round at side zone

Parameter	Striking Value	Grappling Value
Mean (%)	30.26	69.76
SD (%)	31.38	35.31
N	12	12
95% CI	10.33 to 50.2	49.82 to 89.69
Minimum (%)	1	9.5
Maximum (%)	90.5	99

SD (Standard Deviation); CI (Confidence Interval)

Table 6. Comparison between striking times and grappling times at side in Round 1

Two Tailed P value	0.0054**
CI difference	(From -66.06 to -12.93)

CI (Confidence Interval)	**$p \leq 0.01$

3.5 - Analysis of the wall zone in round 1

Table 7 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the wall zone of the cage in round 1. Data in striking showed a minimum time of 0% and a maximum time of 40.9%, with a mean of 4.18% seconds spent during striking phases at the side zone, with a standard deviation (SD) of 11.64% and a Confidence Interval (CI) between -3.22 to 11.57. Data in grappling showed a minimum time of 0% and a maximum time of 100%, with a mean of 87.5% spent during grappling phases at the wall zone, with a standard deviation (SD) of 29.88 and a Confidence Interval (CI) between 68.51 to 106.48. Table 8 shows a comparison of the mean time spent in striking and grappling phases still at the wall zone in round 1 done with a t-student test. Extremely high statistically significant differences ($p<0.05$) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between -76.18 to – 30.66.

Table 7. Descriptive statistic of the first round at wall zone

Parameter	Striking Value	Grappling Value
Mean (%)	4.18	87.5
SD (%)	11.64	29.88
N	12	12
95% CI	-3.22 to 11.57	68.51 to 106.48
Minimum (%)	0	0
Maximum (%)	40.9	100

SD (Standard Deviation); CI (Confidence Interval)

Table 8. Comparison between striking times and grappling times at wall in Round 1

Two tailed P value	Less than 0.0001***
CI difference	(From -76.18 to -30.66)

CI (Confidence Intervall)   ***$p \le 0.001$

3.6 - *Analysis of the round 2*

In round two, 3 zones were analysed with their time divided in striking and grappling; for the centre, side and wall zone, a total of 24 time (N=24) of 12 matches were analysed; after that, a comparison between times in striking and grappling were compared in every of three zone. Table 9 shows the values of the second round for every zone analysed. For the centre zone data in striking and grappling were analysed with a range of time minimum of 0 seconds and a maximum of 65 seconds. The mean time was 23.46 seconds and the standard deviation was of 20.18 seconds. In the side zone, a range of time minimum of 0 seconds and a maximum of 105 seconds with a mean time of 34.21 seconds were found, with a standard deviation of 34.21 seconds. The same analysis was done at the wall zone, with a range of time minimum of 0 seconds and a maximum of 110 seconds, a mean time of 32.33 seconds and a standard deviation was 38.15.

Table 9. Descriptive statistics for the time in the zones of the cage in round 2

		Range		Mean		St. D. (s)
	N° of Times	Minimum time (s)	Maximum time (s)	Value (s)	95% Cl	
Centre	24	0	65	23.46	(14.94 to 31.98)	20.18
Side	24	0	105	34.21	(19.76 to 48.65)	34.21
Wall	24	0	110	32.33	(16.23 to 48.44)	38.15

SE (standard error); CI (confidence interval)

3.7 - Analysis of the centre zone in round 2

Table 10 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the centre zone of the cage in round 2. Data in striking showed a minimum time of 18.1% and a maximum time of 100%, with a mean of 64.78% spent during striking phases at the centre zone, with a standard deviation (SD) of 31.97 and a Confidence Interval (CI) between 44.47 to 85.09. Data in grappling showed a minimum time of 0% and a maximum time of 81.9%, with a mean of 35.23% spent during grappling phases at the centre zone, with a standard deviation (SD) of 31.97% and a Confidence Interval (CI) between 14.92 to 55.54. Table 11 shows a comparison of the mean time spent in striking and grappling phases still at the centre zone in round 2 done with a t student test. No differences (p>0.05) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between 2.49 to 56.62.

Table 10. Descriptive statistic of the first round at centre zone

Parameter	Striking	Grappling
	Value	Value
Mean (%)	64.78	35.23
SD (%)	31.97	31.97
N	12	12
95% CI	32.56 to 65.1	34.91 to 67.45
Minimum (%)	18.1	0
Maximum (%)	100	81.9

SD (Standard Deviation); CI (Confidence Interval)

Table 10. Comparison between striking times and grappling times at centre in Round 2

Two Tailed P value	0.0338*
CI difference	(From 2.49 to 56.62)

CI (Confidence Interval)   *p ≤ 0.05

3.7 - Analysis of the side zone in round 2

Table 12 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the side zone of the cage in round 2. Data in striking showed a minimum time of 0% and a maximum time of 56.2%, with a mean of 14.79% spent during striking phases at the side zone, with a standard deviation (SD) of 16.14 and a Confidence Interval (CI) between 4.53 to 25.04. Data in grappling showed a minimum time of 43.8% and a maximum time of 100%, with a mean of 85.2% spent during grappling phases at the side zone, with a standard deviation (SD) of 16.13% and a Confidence Interval (CI) between 74.96 to 95.45. Table 13 shows a comparison of the mean time spent in striking and grappling phases still at the side zone in round 2 done with a t student test. Highly statistically significant differences (p<0.05) were observed between the time spent on striking and grappling at the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between -84.08 to -56.76.

Table 11. Descriptive statistic of the second round at side zone

Parameter	Striking Value	Grappling Value
Mean (%)	14.79	85.2
SD (%)	16.14	16.13
N	12	12
95% CI	4.53 to 25.04	74.96 to 95.45
Minimum (%)	0	43.8
Maximum (%)	56.2	100

SD (Standard Deviation); CI (Confidence Interval)

Table 13. Comparison between striking times and grappling times at side in Round 2

Two Tailed P value	Less than 0.0001***
CI difference	(From -84.08 to -56.76)

CI (Confidence Interval)   *** p ≤ 0.001

3.8 - Analysis of the wall zone in round 2

Table 14 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the wall zone of the cage in round 2. Data in striking showed a minimum time of 0% and a maximum time of 21.4%, with a mean of 4.89% spent during striking phases at the wall zone, with a standard deviation (SD) of 7.35% and a Confidence Interval (CI) between 0.22 to 9.56. Data in grappling showed a minimum time of 78.6% and a maximum time of 100%, with a mean of 95.12% spent during grappling phases at the wall zone, with a standard deviation (SD) of 22.04% and a Confidence Interval (CI) between 90.45 to 99.79. Table 15 shows a comparison of the mean time spent in striking and grappling phases still at the wall zone in round 2 done with a t student test. Very highly significant differences (p<0.05) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between -78.58 to -36.42.

Table 12. Descriptive statistic of the second round at wall zone

Parameter	Striking Value	Grappling Value
Mean (%)	4.89	95.12
SD (%)	7.35	22.04
N	12	12
95% CI	0.22 to 9.56	90.45 to 99.79
Minimum (%)	0	78.6
Maximum (%)	21.4	100

SD (Standard Deviation); CI (Confidence Interval)

Table 13. Comparison between striking times and grappling times at wall in Round 2

Two Tailed P value	less than 0.0001***
CI difference	(From -78.58 to -36.42)

CI (Confidence Interval)   ***p ≤ 0.001

*3.9 - _Analysis of the round 3_*

In round three, 3 zones were analysed with their time divided in striking and grappling, for a total of 24 time (N=24) of 12 matches, for the centre, side and wall zone; after that, a comparison between times in striking and grappling were compared in every of three zone. Table 16 shows the values of the second round for every zone analysed. For the centre zone, a range of minimum time of 0 seconds and a maximum of 69 seconds were found, a mean time of 21.67 seconds and a standard deviation of 21.04 seconds. For the side zone both in striking and grappling, a range of minimum time of 0 seconds and a maximum of 137 seconds were found, with an average time of 34.46 seconds and a standard deviation of 40.16 seconds. At the wall zone, minimum time of 0 seconds and a maximum time of 108 seconds were found, with an average time of 33.88 seconds, and a standard deviation of 38.54 seconds.

Table 14. Descriptive statistics for the time in the zones of the cage in round 3

| | N° of Times | Range | | Mean | | St. D. (s) |
		Minimum time (s)	Maximum time (s)	Value (s)	95% Cl	
Centre	24	0	69	21.67	(12.78 to 30.55)	21.04
Side	24	0	137	34.46	(17.50 to 51.42)	40.16
Wall	24	0	108	33.88	(17.60 to 50.15)	38.54

SE (standard error); CI (confidence interval)

3.10 - Analysis of the centre zone in round 3

Table 17 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the centre zone of the cage in round 3. Data in striking showed a minimum time of 26.9% and a maximum time of 100%, with a mean of 74.1% spent during striking phases at the centre zone, with a standard deviation (SD) of 30.93% and a Confidence Interval (CI) between 54.46 to 93.75. Data in grappling showed a minimum time of 0% and a maximum time of 73.1%, with a mean of 25.9% spent during grappling phases at the centre zone, with a standard deviation (SD) of 30.93% and a Confidence Interval (CI) between 6.26 to 45.55. Table 18 shows a comparison of the mean time spent in striking and grappling phases still at the centre zone in round 3 done with a t student test. Highly statistically significant differences ($p<0.05$) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between from 22.02 to 74.39.

Table 15. Descriptive statistic of the third round at centre zone

Parameter	Striking	Grappling
	Value	Value
Mean (%)	74.1	25.9
SD (%)	30.93	30.93
N	12	12
95% CI	54.46 to 93.75	6.26 to 45.55
Minimum (%)	26.9	0
Maximum (%)	100	73.1

SD (Standard Deviation); CI (Confidence Interval)

Table 16. Comparison between striking times and grappling times at centre in Round 3

Two Tailed P value	0.0009***
CI difference	From 22.02 to 74.39

CI (Confidence Interval)   ***$p \leq 0.001$

3.11 - Analysis of the side zone in round 3

Table 19 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the side zone of the cage in round 2. Data in striking showed a minimum time of 0% and a maximum time of 78.6%, with a mean of 14.25% spent during striking phases at the side zone, with a standard deviation (SD) of 22.03% and a Confidence Interval (CI) between 0.25 to 28.24. Data in grappling showed a minimum time of 21.4% and a maximum time of 100%, with a mean of 85.77% spent during grappling phases at the side zone, with a standard deviation (SD) of 22.04% and a Confidence Interval (CI) between 71.77 to 99.77. Table 20 shows a comparison of the mean time spent in striking and grappling phases still at the side zone in round 3 done with a t student test. Highly statistically significant differences ($p<0.05$) were observed between the time spent on striking and on grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between 22.02 to 74.39.

Table 17. Descriptive statistic of the third round at side zone

Parameter	Striking Value	Grappling Value
Mean (%)	14.25	85.77
SD	22.03	22.04
N	12	12
95% CI	0.25 to 28.24	71.77 to 99.77
Minimum (%)	0	21.4
Maximum (%)	78.6	100

SD (Standard Deviation); CI (Confidence Interval)

Table 18. Comparison between striking times and grappling times at side in Round 3

The two-tailed P value equals	0.0009***	
CI difference	(From 22.02 to 74.39)	
CI (Confidence Interval)		***$p \leq 0.001$

3.12 - Analysis of the wall zone in round 3

      Table 21 shows the total of rounds analysed in striking (N=12) and grappling (N=12) at the wall zone of the cage in round 3. Data in striking showed a minimum time of 0% and a maximum time of 68.7%, with a mean of 8.05% spent during striking phases at the wall zone, with a standard deviation (SD) of 19.33% and a Confidence Interval (CI) between -4.24 to 20.32. Data in grappling showed a minimum time of 31.3% and a maximum time of 100%, with a mean of 91.96% spent during grappling phases at the wall zone, with a standard deviation (SD) of 19.33% and a Confidence Interval (CI) between 79.69 to 104.24. Table 22 shows a comparison of the mean time spent in striking and grappling phases still at the wall zone in round 3 done with a t student test. Extremely high significant differences (p<0.05) were observed between the time spent on striking and grappling on the centre zone considering the total rounds in analysis, with a Confidence Interval (CI) between -100.28 to -67.56.

Table 19. Descriptive statistic of the third round at wall zone

Parameter	Striking	Grappling
	Value	Value
Mean (%)	8.05	91.95
SD (%)	19.33	19.33
N	12	12
95% CI	-4.24 to 20.32	79.69 to 104.24
Minimum (%)	0	31.3
Maximum (%)	68.7	100

SD (Standard Deviation); CI (Confidence Interval)

Table 20. Comparison between striking times and grappling times at wall in Round 3

Two-tailed P value	Less than 0.0001***
CI difference	From -100.28 to -67.56

CI (Confidence Interval)	***p ≤ 0.001

3.13 - Comparisons in Round 1 between striking and grappling times

Table 23 shows a descriptive analysis of the firsts round in striking (N=12) and grappling (N=12). Data in striking showed a minimum time of 7.2% and a maximum time of 63.9%, with a mean of 27.23% of time spent during striking phases in the total of rounds 1, with a standard deviation (SD) of 6.51%, and a Confidence Interval (CI) between 12.91 to 41.55. Data in grappling phases in round 1 showed a minimum time of 36.1% and a maximum time of 63.9%, with a mean of 77.78%, with a standard deviation (SD) of 22.55% and a Confidence Interval (CI) between 58.46 to 87.1. Table 24 shows a comparison of the mean of total time spent in striking and grappling phases in round one done with a t student test. Highly statistically significant differences ($p<0.05$) were observed between the time spent on striking and grappling considering the total rounds in analysis, with a Confidence Interval (CI) between -39.51 to -4.24.

Table 21. Descriptive statistic of the total times of grappling and striking for round 1

Parameter	Striking Value	Grappling Value
Mean (%)	27.23	72.78
SD (%)	6.51	22.55
N	12	12
95% CI	12.91 to 41.55	58.46 to 87.1
Minimum (%)	7.2	36.1
Maximum (%)	63.9	92.8

SD (Standard Deviation); CI (Confidence Interval)

Table 22. Comparison between striking times and grappling times in Round 1

Two-tailed P value	0.0162*
CI difference	From -39.51 to -4.24

CI (Confidence Interval)   *$p \leq 0.05$

3.14 - Comparisons in Round 2 between striking and grappling times

Table 25 shows a descriptive analysis of the seconds round in striking (N=12) and grappling (N=12). Data in striking showed a minimum time of 2.2% and a maximum time of 48.9%, with a mean of 20.76% of time spent during striking phases in the total of rounds 2, with a standard deviation (SD) of 13.17%, and a Confidence Interval (CI) between 12.4 to 29.13. Data in grappling phases in round 2 showed a minimum time of 51.1% and a maximum time of 97.8%, with a mean of 79.25%, with a standard deviation (SD) of 13.17% and a Confidence Interval (CI) between 70.88 to 87.61. Table 26 shows a comparison of the mean of total time spent in striking and grappling phases in round one done with a t student test. Highly statistically significant differences ($p<0.05$) were observed between the time spent on striking and grappling considering the total rounds in analysis, with a Confidence Interval (CI) between -45.26 to -11.57.

Table 23. Descriptive statistic of the total times of grappling and striking for round 2

	Striking	Grappling
Parameter	Value	Value
Mean (%)	20.76	79.25
SD (%)	13.17	13.17
N	12	12
95% CI	12.4 to 29.13	70.88 to 87.61
Minimum (%)	2.2	51.1
Maximum (%)	48.9	97.8

SD (Standard Deviation); CI (Confidence Interval)

Table 24. Comparison between striking times and grappling times in Round 2

Two-tailed P value	0.0014**
CI difference	From -45.26 to -11.57

CI (Confidence Interval) $**p \leq 0.01$

3.15 - Comparisons in Round 3 between striking and grappling times

Table 27 shows a descriptive analysis of the thirds round in striking (N=12) and grappling (N=12). Data in striking showed a minimum time of 7.8% and a maximum time of 76.1% with a mean of 20.47% of time spent during striking phases in the total of rounds 3, with a standard deviation (SD) of 19.25%, and a Confidence Interval (CI) between 8.24 to 32.7. Data in grappling phases in round 3 showed a minimum time of 23.9% and a maximum time of 92.2%, with a mean of 79.54%, with a standard deviation (SD) of 19.25% and a Confidence Interval (CI) between 67.31 to 91.77. Table 28 shows a comparison of the mean of total time spent in striking and grappling phases in round one done with a t student test. Very statistically significant differences (p<0.05) were observed between the time spent on striking and grappling considering the total rounds in analysis, with a Confidence Interval (CI) between -47.28 to -11.64.

Table 25. Descriptive statistic of the total times of grappling and striking for round 3

Parameter	Striking Value	Grappling Value
Mean (%)	20.47	79.54
SD (%)	19.25	19.25
N	12	12
95% CI	8.24 to 32.67	67.31 to 91.77
Minimum (%)	7.8	23.9
Maximum (%)	76.1	92.2

SD (Standard Deviation); CI (Confidence Interval)

Table 26. Comparison between striking times and grappling times in Round 3

Two-tailed P value	0.0017**
CI difference	From -47.28 to -11.64

CI (Confidence Interval)   **p ≤ 0.01

The aim of this study was to find out a comparison between the mean of the striking and grappling time fought inside the cage and which of the two fighting style is more used in the three areas of the fighting ground (centre, side or wall). 16 matches with 3 rounds each one were analysed through a video analysis in slow motion to reduce the percentage of error. This study included only matches protracted until the end of the third round and won by judges' decision, excluding every fight ended before the limit. 4 matches were removed from the analysis. All the athletes were males, born in Portugal and coming from local MMA team, with an average age between 24 and 28 years old and an average experience of training between 2 and 12 years. All the data were collected and analysed in the next days of the competition.

3.16 The centre zone of the cage in round 1, 2 and 3

Results showed how in round one, there were no significant differences in means between time spent at the centre of the cage between striking and grappling; in round two a significant different in means between striking and grappling was found ($p = 0.00338$, $p \leq 0.05$); in round 3, high significant difference between the two values was found, ($p = 0.0009$, $p \leq 0.001$). Due to the rules, athletes must start the fight at the centre zone at the beginning of every round, that is why the firsts phases of the fight are set on the centre zone. During these phases, (even in second and third round when athletes are more rested than the other phases of the fight due to the minute of rest at the end of the three minutes) fighters tends to use the centre of the cage for really intensive actions (Miarika et al. 2016) both in striking and grappling. In MMA a striking phase is usually followed by a takedown, a common action that needs a lot of energy (Kirk, Hurst and Atkins, 2015); Results showed that in MMA, the centre is used for the firsts phases especially in striking.

3.17 - The side zone of the cage in round 1, 2 and 3

Results showed a very significant difference in round 1, 2 and 3 between striking and grappling at the side zone ($p \leq 0.001$). It is possible to suppose that the side zone is used in intermediate phases when an athlete uses to attack the other one in striking position trying to finish in a takedown position after an action focused on bringing the opponent to the wall (Miarka, Coswig and Amtmann, 2019). Another interesting fact is that means of striking going to a decreasing value each round despite the means of the grappling times that going to an increasing value each round. The differences in time are explained because athletes use to rest more in grappling position despite the striking position (Adam et al., 2015), and that is why towards the third rounds fighters tend to spend more time in the grappling position.

3.18 - The wall zone of the cage in round 1, 2 and 3

Very significant differences were found between the means of the striking and grappling phases in each one of the three rounds at the wall zone ($p \leq 0.001$), showing a predominance percentage in grappling actions. Firsts phases of the match are held at the centre zone, and fights start in striking position (Miarka, Coswig and Amtmann, 2019); after that, results showed that athletes use to try to bring the opponent to the ground. This lead that a grappling phase at the wall zone is forced by takedown actions in order to move the fight in a groundwork. This fact can happen because of athletes use the grappling position to rest (Coswig, Ramos and Del Vecchio, 2016) or finish quickly the fight trying to bring the opponent to draw.

4 - CONCLUSION AND RECOMMENDATIONS FOR FUTURE STUDIES

In MMA, every fighter has the own fighting style given from his fighting school. A lot of MMA athletes have often a specific background in others martial arts: it is possible to find out who is stronger in standing position despite of the ground position and vice versa (Buse, 2006). The fighting style depends on the Academy of provenience and this can lead to deduce that doesn't exist a specific fighting style's background in MMA (Buse, 2006). Anyway in order to have a practical classification of the fighting style, it is possible to divide the MMA fighting style in "striking" and "grappling". This research analysed the comparison between the means of the striking time and the grappling time in three round of three minutes. The results showed a significant difference between data. The total analysis suggests that athletes seem to prefer the ground fight despite the striking fight. This can depend from some factors: First of all, the ground fight is used from athletes not only to finish the fight through finalization (choke, guillotine, armbar, etc.) but also to rest (Adam et al., 2015). In fact MMA athletes use to perform the fights in really high but short intensity phases and long rest phases (Del Vecchio, Hirata & Franchini, 2011; Coswig, Ramos and Del Vecchio, 2016) due to the great effort that a MMA match needs to be performed (Slimani et al., 2017); other reason can depend from the nature of the MMA fights. During a study, it was demonstrated that most of the fighters use to come from grappling fighting styles as jiu-jitsu, wrestling or greek-roman wrestling (Buse, 2006) and even if most of the modern MMA schools tend to prepare athletes under every fight aspect, from striking to grappling, most of them use to imprint the fight on the ground (Sheard, 2004; James et al., 2016). The trend of the matches analysed in this study showed that the initial phases are always in standing up position, but there is no difference in time at centre zone between striking and grappling, but the striking phases showed that can be crucial to decide the next phases of the fight that tend to be imprinted on the ground fighting in every of the three rounds, especially for the side and wall zone of the cage; this can lead a trainer a new approach for the methodologies of the training in physical conditioning, technical and tactical aspects, starting from the point that a MMA match begins with high intensive standing up phases until athletes go to the ground to continue the fight.

This study cannot represent a certain strategy on MMA due to a lot of variables that can be present during a fight, like the fighting style of an athlete, that could be different because of the school of provenience, or the weight category, where heavier athletes can present a difference in fighting style due to their body mass.

Others variables can be added for further studies: matches analysed were the only ones ended by judges' decision, the variable of "zones of the fight in matches ended before the limit" can be added in a future study; samples were only born in Portugal, but another variable like "fighters born in others country" can be analysed. That is why, future researches should be done with a larger sample and approach.

MMA is a new born sport where the literature is poor and the lack of the history, technical and tactical aspects are still to define, that is why is difficult for coaches to give the right interpretation of the fighting style, and to find a right methodology to prepare an athlete; anyway, if they look at the multidimensional aspects of their MMA athletes and continue to analyse all the variables of matches, continue to study, get wrong and experiment new methodology of training and analysis they will be finally able to write the new history of this fantastic sport.

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APPENDIX

Faculty of Sports Science and Physical Education ● University of Coimbra

DECLARATION OF PUBLIC DOMAIN

The athlete _____ born in _____ the _____

Declare that I am compliant to be filmed during my fight held in Porto (Portugal) the 5th of May 2018 at the amateur sporting event "MMA NATIONAL TRYALS PORTUGAL" and I authorize the treatment of my video recording for research studies and make it public domain.

Signature of the athlete

_____

05/05/2018

Porto (PT)

Appendix B) – Matches of the first round

Match n°1					
Centre		Side		Wall	
29,4		18,9		51,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
24,5	75,5	5,9	94,1	1,1	98,9
Match n°2					
Centre		Side		Wall	
17,8		30,6		51,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
28,1	71,9	10,9	89,1	1,1	98,9
Match n°3					
Centre		Side		Wall	
25,6		23,9		50,6	
Striking	Grappling	Striking	Grappling	Striking	Grappling
19,6	80,4	14	86	0	100
Match n°4					
Centre		Side		Wall	
32,8		29,4		37,8	
Striking	Grappling	Striking	Grappling	Striking	Grappling
54,2	45,8	13,2	86,8	1,5	98,5
Match n°5					
Centre		Side		Wall	
66,7		26,7		6,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
8,3	91,7	6,3	93,8	0	100
Match n°6					
Centre		Side		Wall	
29,4		70,6		0	
Striking	Grappling	Striking	Grappling	Striking	Grappling
54,7	45,3	6,3	93,7	0	0
Match n°7					
Centre		Side		Wall	
53,3		22,2		24,4	
Striking	Grappling	Striking	Grappling	Striking	Grappling
66,7	33,3	72,5	27,5	40,9	59,1
Match n°8					
Centre		Side		Wall	
69,4		11,7		18,9	
Striking	Grappling	Striking	Grappling	Striking	Grappling
76,8	23,2	90,5	9,5	0	100
Match n°9					

Centre		Side		Wall	
29,4		53,9		16,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
49,1	50,9	1	99	0	100
Match n°10					
Centre		Side		Wall	
20,6		15		64,4	
Striking	Grappling	Striking	Grappling	Striking	Grappling
89,2	10,8	37	63	4,3	95,7
Match n°11					
Centre		Side		Wall	
32,2		20,6		47,2	
Striking	Grappling	Striking	Grappling	Striking	Grappling
37,9	62,1	32,4	67,6	1,2	98,8
Match n°12					
Centre		Side		Wall	
69,4		14,4		16,1	
Striking	Grappling	Striking	Grappling	Striking	Grappling
76,8	23,2	73,1	26,9	0	100

Match n°1					
Centre		Side		Wall	
29,4		18.9		51,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
51,1	48,9	14	86	2,4	97,6
Match n°2					
Centre		Side		Wall	
17,8		30,6		51,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
65,7	34,3	21,2	78,8	1,8	98,2
Match n°3					
Centre		Side		Wall	
25,6		23,9		50,6	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	22,9	77,1	10,9	89,1
Match n°4					
Centre		Side		Wall	
32,8		29,4		37,8	
Striking	Grappling	Striking	Grappling	Striking	Grappling
53,8	46,2	4,5	95,5	3,4	96,6
Match n°5					
Centre		Side		Wall	
66,7		26,7		6,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
18,1	81,9	8,6	91,2	0	100
Match n°6					
Centre		Side		Wall	
29,4		70,6		0	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	2,4	97,6	0	100
Match n°7					
Centre		Side		Wall	
53,3		22,2		24,4	
Striking	Grappling	Striking	Grappling	Striking	Grappling
87,8	12,2	56,2	43,8	16,7	83,3
Match n°8					
Centre		Side		Wall	
69,4		11,7		18,9	

Striking	Grappling	Striking	Grappling	Striking	Grappling
26	74	0	100	0	100

Match n°9					
Centre		Side		Wall	
29,4		53,9		16,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	5,1	94,9	0	100

Match n°10					
Centre		Side		Wall	
20,6		15		64,4	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	13,2	86,8	21,4	78,6

Match n°11					
Centre		Side		Wall	
32,2		20,6		47,2	
Striking	Grappling	Striking	Grappling	Striking	Grappling
48,8	51,2	29,3	70,7	2	98

Match n°12					
Centre		Side		Wall	
69,4		14,4		16,1	
Striking	Grappling	Striking	Grappling	Striking	Grappling
26	74	0	100	0	100

Appendix D) – Matches of the third round

Match n°1					
Centre		Side		Wall	
49,4		23,9		26,7	
Striking	Grappling	Striking	Grappling	Striking	Grappling
36,0	64,0	7,0	93,0	4,2	95,8
Match n°2					
Centre		Side		Wall	
58,9		23,9		17,2	
Striking	Grappling	Striking	Grappling	Striking	Grappling
50,9	49,1	18,6	81,4	6,5	93,5
Match n°3					
Centre		Side		Wall	
8,3		31,7		60,0	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	12,3	87,7	4,6	95,4
Match n°4					
Centre		Side		Wall	
37,2		44,4		18,3	
Striking	Grappling	Striking	Grappling	Striking	Grappling
26,9	73,1	1,3	98,8	3,0	97,0
Match n°5					
Centre		Side		Wall	
22,2		31,7		46,1	
Striking	Grappling	Striking	Grappling	Striking	Grappling
27,5	72,5	7,0	93,0	0	100
Match n°6					
Centre		Side		Wall	
1,1		33,3		65,6	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	3,3	96,7	8,5	91,5
Match n°7					
Centre		Side		Wall	
47,2		15,6		37,2	
Striking	Grappling	Striking	Grappling	Striking	Grappling
81,2	18,8	78,6	21,4	68,7	31,3
Match n°8					
Centre		Side		Wall	
8,9		75,6		15,6	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	0	100	0	100
Match n°9					

Centre		Side		Wall	
19,4		39,4		41,1	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	0	100	0	100
Match n°10					
Centre		Side		Wall	
7,8		39,4		52,8	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	15,5	84,5	0	100
Match n°11					
Centre		Side		Wall	
20,0		24,4		55,6	
Striking	Grappling	Striking	Grappling	Striking	Grappling
66,7	33,3	27,3	72,7	1	99
Match n°12					
Centre		Side		Wall	
8,3		76,1		15,6	
Striking	Grappling	Striking	Grappling	Striking	Grappling
100	0	0	100	0	100