

PSYCHOLOGY

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The effect of absent audiences on Mixed Martial Arts performance during COVID-19

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Abstract

Background. This paper investigates the effect of the presence of spectators on performance in a previously unexplored mixed martial arts environment. In this sport, athletes have considerable motivation to finish a fight before the time limit. These incentives are financial but are also demanded directly by the fans and give the fighter the certainty of victory.

Problem and aim. Audiences can influence athletes' performance, by serving as a motivator or a stressor. This paper aims to investigate the impact of the presence of spectators on the ability of fighters to deliver a finish before the time limit.

Material and methods. The data used is from the Ultimate Fighting Championship between 2019 and 2020. The first year was before COVID-19 with audiences and the second was during COVID-19 without any. Models were built to reveal the effect of spectators on the frequency of finishes before the time limit.

Results. The results show a negative effect of the presence of the audience on finishing before the time limit. However, for women, the findings are not as conclusive.

Conclusions. The paper also discusses interventions that can lead to the elimination of the negative effect of spectators on performance.

Introduction

Combat sports have always had a firm place with sports audiences. Boxing is one of the most popular, with the biggest fights in history being watched by around 100,000 spectators in the stadium [Hewlett 2022]. One of the clear trends of today is Mixed Martial Arts (MMA), which has been steadily growing in popularity since the establishment of The Ultimate Fighting Championship (UFC) in the 1990s. In the last five years, it has even been the fastest-growing sport [Parimatch 2022]. In 2021, the UFC's revenues were over \$1 billion [Moody's 2022]. Behind this popularity are various starfighters.

For example, Conor McGregor is followed by millions of fans on social media [Instagram 2022].

Some space is also devoted to MMA in research, although this is more of a pioneering work than a comprehensive view of the sport's core. Mention may be made, for example, of Gift [2018, 2020] who examines the effects on fighter wages and referee bias. Deng [2022], Devlin *et al.* [2016], and Kirkwood *et al.* [2019] examine MMA fans, their characteristics, and their motivations for consumption. Furthermore, the influences on fighters' performance in fights are examined. Mention can be made of Andrade *et al.* [2020], and Chen and Cheesman [2013] who examine the psychological factors and mental toughness of fight-

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ers. James *et al.* [2017], and Kirk *et al.* [2020] examine the physical influences and prerequisites for success in fights. Chernozub *et al.* [2018] studied the optimal training plan for MMA fighters based on their fighting style.

Another major reason for the popularity of MMA is its unpredictability [Wray 2021]. Fights may end after the time limit at the referees' decision or by finishing before the time limit. The following situations may occur when a three-referee decision is made. A *unanimous decision win* (U-DEC) means that all three referees choose the same fighter as the winner. *Majority decision win* (M-DEC) means that two referees choose one fighter to win the fight and the third referee scores it a draw. *Split decision win* (S-DEC) means that two referees choose one fighter to win the fight and the third referee has the other fighter win it. Finishing before the time limit is typically divided into two categories, namely *knockout* or *technical knockout* (KO/TKO) and *submission* (SUB). The term knockout means any strike or a combination of strikes from one fighter that leaves their opponent unable to continue. A technical knockout refers to a fighter being overwhelmed by the attack of their opponent and showing insufficient signs of defence. In this case, a referee must stop the fight and prevent any further damage to the defeated fighter. There are two categories of submission. The first is a joint lock where there is a risk of injury to the joint and so the fighter taps out. The second category is chokehold where there is a risk of passing out due to lack of blood to the brain, so the fighter is forced to submit to retain consciousness [Stellpflug *et al.* 2020]. Thus, in an MMA fight, one fighter might be winning the entire fight, and the referee would declare him the winner, but just before the end, the opponent would finish him before the time limit. In recent history, title fights like Kamaru Usman vs Leon Edwards or Glover Teixeira vs Jiri Prochazka could be mentioned [UFC.com 2022]. In the first case, it was KO/TKO, in the second case, it was SUB. The fighters have the incentive to finish the fight before the time limit so they don't have to worry about the referees' decision and have the certainty of victory.

At the same time, it should be emphasized that fans of combat sports love finishing before the time limit [Fusco 2013]. The epic shots, especially of KO/TKO, are then admired and shared on social media and discussed by fans for a long time. Organizations like the UFC then try to motivate fighters to try to finish before the time limit with bonuses for the best finish or performance in the tournament.

This paper examines precisely the effects on finishing before the time limit in MMA fights. Specifically, the main influence examined is the presence of the audience in the arena. In sports, the audience can act as a motivational [Courneya, Carron 1992] but also as a stress factor [Wallace *et al.* 2005] in general.

The period of COVID-19 pandemic brought many complications to the sports industry but provided

researchers with the right conditions for a unique natural experiment. In many sports, including MMA, organizations had to close arenas to the audience. Thus, this paper compares the period before COVID-19 with a full audience and the period during COVID-19 without an audience. It is therefore possible to quantify the effect of the audience on the frequency of fights being finished before the time limit. Thus, a major added value of this research is the investigation of the effect of audience absence on athlete performance in a previously unexplored combat sports context. The general results show that the presence of the audience reduces the frequency of finishes before the time limit. However, this result is reversed for women.

Literature

In a sports environment, performance was monitored even more than in a regular work environment. To be successful, an athlete had to not falter at important moments. Thus, researchers paid considerable attention to the influences on athletes' performance in different situations [Sarkar, Fletcher 2014] and conditions [Wu *et al.* 2023]. The effect of stressful situations on performance was investigated. In these situations, the athlete was unable to perform at their optimal level, and choking under pressure occurred [Jordet 2009; Tauer *et al.* 2009; Mesagno *et al.* 2015; Prieto *et al.* 2015]. However, there were also situations where stress would have a positive effect on performance. Such situations were called *excelling under pressure* [Jordet, Hartman 2008].

One of the stress factors could be the presence of the audience in the stadium [Picazo-Tadeo *et al.* 2017]. Logically, it was assumed that in a home environment, the audience would bring support to the home team [Courneya, Carron 1992; Goumas 2017; Sors *et al.* 2022]. However, past research showed that the influence of domestic audiences could be ambivalent. Indeed, home audiences could act as a motivating factor, as shown, for example, by Bucciol and Castagnetti [2020] in archery, but only for women. Jane [2022] came to the same conclusion as for the star players in baseball. For nonstar players, however, the audience size effect was negative. The positive effect of the home environment was also confirmed by Boudreaux *et al.* [2017] in the example of basketball and Krumer [2017] in judo. However, a larger number of papers showed that home audiences were more likely to be a stress factor [Wallace *et al.* 2005]. This phenomenon was manifested, for example, in basketball during free throws [Boheim *et al.* 2019], in soccer during penalty kicks [Dohmen 2008], and in the biathlon during shooting [Harb-Wu, Krumer 2019]. However, for example, Cao *et al.* [2011] showed the insignificance of the influence of the basketball audience in the home environment on performance.

The COVID-19 pandemic provided a unique research opportunity, forcing many competitions to continue without an audience. This offered the researchers data from the natural experiment to compare the situation with and without audiences [Bryson *et al.* 2021; Correia-Oliveira, Andrade-Souza 2022; Couto, Sayers 2022; Samuel *et al.* 2023]. A similar strategy is used in this paper. Ferraresi and Gucciardi [2021] used this situation to investigate the effect of the audience on the probability of missing a penalty kick. They showed that home teams playing without an audience were more likely to miss a penalty kick, while away teams playing without an audience were more likely to convert a penalty kick. This effect was stronger the higher the attendance at the stadium before the pandemic. Thus, the authors showed that fans give the home team an advantage.

Markwell *et al.* [2021] came to a different conclusion using the example of the North American National Basketball League. They showed that the absence of an audience generally increases the success rate of free throws. The authors thus showed that in basketball, the audience can act as a stress factor. The top ten European basketball leagues were examined by De Angelis and Reade [2022] who showed a significant reduction of the previous home advantage.

Fischer and Haucap [2021] explored the European soccer environment. Specifically, they focused on the top three German football divisions in the 2019/2020 season. The authors showed a significant reduction of the previous home advantage in the first division, whereas no change was observed in the second and third divisions.

Losak and Sabel [2021] examined the impact of missing audiences during the COVID-19 pandemic using Major League Baseball as an example. However, they failed to find evidence for a difference between pre-pandemic and pandemic seasons. Thus, the authors concluded that the home-field advantage in the baseball environment cannot be attributed to the effect of the audience in the stadium.

Overall, numerous researchers have utilized closed stands to study the influence of the audience at matches. However, it is essential to acknowledge that the COVID-19 period brought about other effects beyond the absence of spectators. For instance, there could be differences in the health of the athletes during these periods, changes in training practices, and various other factors that may have impacted the outcomes.

Lastly, the robust literature on interventions to reduce the impact of stressors on athlete performance should be mentioned. There are a large number of these interventions [Gröpel, Mesagno 2019]. As the intervention is not the main focus of this paper, only a few options are presented. The first is the pre-performance routine. This intervention may consist of, for example, deep breathing, cue words, the countdown to performance, or some more sophisticated cognitive and behavioural

preparation. This method is proving useful, for example, in tennis. However, with shooting accuracy in soccer and Australian football, its results are ambiguous [Gröpel, Mesagno 2019].

Another simple intervention is left-hand contractions. This, in turn, proves to be a suitable intervention for resisting pressure during penalty kicks or in gymnastics. The last intervention mentioned is the so-called dual task. This aims to distract attention from the stressfulness of the situation by employing execution using parallel task-irrelevant activities. This intervention is useful, for example, in basketball free throw and golf putt [Gropel, Mesagno 2019].

Materials and methods

The paper draws on UFC data available on Kaggle [Dabbert 2021; Warrior 2021]. The data was verified against official statistics on the official UFC website [UFC.com 2022]. In the following lines, the variables that enter the model will be presented in more detail. As already mentioned, the model aims to reveal the effects on fight finish before the limit.

The main independent variable is the presence of the audience at the tournament and its effect on the probability of an early fight finish. Two comparison periods were selected, one completely without any audience and the other corresponding in time to the first one but one year earlier. That is, in a situation where audience presence was not restricted in any way. The first period, in which completely audienceless UFC tournaments took place, began on March 14, 2020, with UFC Fight Night: Lee vs. Oliveira in Brasília, Brazil, and ended on December 19, 2020, with UFC Fight Night: Thompson vs. Neal in Las Vegas, Nevada. The following event UFC on ABC: Holloway vs. Kattar on January 16, 2021, in Abu Dhabi, United Arab Emirates has already taken place in front of roughly 2,000 spectators.

Table 1 shows the descriptive statistics of fighters who participated in fights during the period under study, specifically their height, weight, reach, and age. These data are provided to offer a comprehensive understanding of the fighters, although the analysis itself focuses on entire fights rather than individual fighters. Throughout the study, fights were attended by 118 different women and 584 different men.

Table 1. Descriptive statistics of the tested fighters

	Mean	Median	SD	Min	Max
Height (cms)	177.42	177.80	9.58	152.40	210.82
Reach (cms)	182.00	182.88	11.43	147.32	214.63
Weight (kg)	73.75	70.31	16.65	52.16	120.20
Age	30.31	30.00	4.09	20.00	45.00

For the comparison of the influence of the audience, the period from March 14, 2019, to December 19, 2019,

was chosen. Which corresponds to the events from UFC Fight Night: Till vs. Masvidal in London, England to UFC 245: Usman vs. Covington in Las Vegas, Nevada. Fights analyzed are those that resulted in finishes by SUB, KO/TKO, U-DEC, S-DEC, and M-DEC. A total of 731 fights are analyzed. The number of 351 (48.02%) took place in front of an audience and 380 (51.98%) took place without an audience. The used variable is named *Empty Arena* which takes the value of 1 if the fight was without an audience and the value of 0 if the fight was with an audience.

The dependent variable is a dummy variable *Finish* which takes the value of 1 if the fight was finished before the time limit and the value of 0 if the winner was determined by the referees' decision after the time limit expired. The frequency of the categories is given in Table 2.

Table 2. Fights by finish

Finish	Empty arena	With audience	Total
SUB	72 (20.51 %)	55 (14.47 %)	127 (17.37 %)
KO/TKO	112 (31.91 %)	118 (31.05 %)	230 (31.46 %)
U-DEC	142 (40.46 %)	169 (44.47 %)	311 (42.54 %)
S-DEC	24 (6.84 %)	35 (9.21 %)	59 (8.07 %)
M-DEC	1 (0.28 %)	3 (0.79 %)	4 (0.55 %)
Total	380	351	731

Note: Shares of finishes are in parentheses.

The most common method of finishing is U-DEC. However, finishes before the time limit for KO/TKO and SUB follow. Overall, 357 fights are finished before the time limit and 374 fights are finished by decision. Without an audience, 184 (52.42%) fights are finished before the time limit and 167 (47.58%) fights are finished by referees' decision. With an audience, 173 (45.53%) fights are finished before the time limit and 207 (54.47%) fights are finished by referees' decision. If finishing before the time limit is considered, the mean difference is 0.06* (p-value < 0.1), and the difference is statistically significant as tested by a two-tailed unpaired t-test. Fights held behind closed doors were found to be six percentage points more likely to end before the time limit. However, this difference is primarily attributed to the higher number of SUB. The difference in the number of KO/TKO is not statistically significant. Also, it should be emphasized that when the same test is applied to the two periods before COVID-19, namely the years 2018 and 2019, there is no statistical difference between these pre-COVID-19 periods.

The following lines present the control independent variables, meaning other possible influences on the dependent variable. The first control independent variable is the probability of the favourite winning using the betting odds. This variable is named *Odds*. If a fight has a clear favourite, this indicates an assumed large difference between the performance of the fighters. If one

fighter is much better than the other, they should have a higher probability of finishing the fight before the time limit. Betting odds are also able to capture other influences on a fighter's performance in a fight. For example, home advantage has often been described in previous literature [Krumer 2017; Lago-Penas *et al.* 2017; Pollard, Armatas 2017; Leite, Almeida 2018; Rooney, Kennedy 2018; Bucciol, Castagnetti 2020]. The betting odds should also be able to capture this effect. The betting odds are modified according to the following formula. And the probability of the favourite winning is used.

Odds =

$$= \frac{\text{European betting odds on the opponent to win}}{\text{European betting odds on the opponent to win} + \text{European odds to win}}$$

Another possible influence and therefore a control variable is the gender of the fighter [Cremades *et al.* 2013; Pereira Martins *et al.* 2019; Rutkowska, Gierczuk 2020]. An empty arena may have different effects on men and women. Following the pattern of previous literature [Cohen-Zada *et al.* 2017], this effect is examined using an interaction term as the product of a dummy variable for the empty arena and gender. The variable is named *Empty Arena * Gender*. To give an overview, it is worth noting that there are 118 women and 584 men in the dataset.

Table 3. Fights by weight classes

Weight class	Empty arena	With audience	Total
Flyweight 56.7 kg	15 (4.27 %)	10 (2.63 %)	25 (3.42 %)
Bantamweight 61.2 kg	35 (9.97 %)	41 (10.79 %)	76 (10.40 %)
Featherweight 65.8 kg	46 (13.11 %)	45 (11.84 %)	91 (12.45 %)
Lightweight 70.3 kg	37 (10.54 %)	60 (15.79 %)	97 (13.27 %)
Welterweight 77.1 kg	42 (11.97 %)	57 (15.00 %)	99 (13.54 %)
Middleweight 83.9 kg	34 (9.69 %)	39 (10.26 %)	73 (9.99 %)
Light Heavyweight 93.0 kg	28 (7.98 %)	33 (8.68 %)	61 (8.34 %)
Heavyweight 120.2 kg	37 (10.54 %)	26 (6.84 %)	63 (8.62 %)
Women's Strawweight 52.2 kg	22 (6.27 %)	19 (5.00 %)	41 (5.61 %)
Women's Flyweight 56.7 kg	27 (7.69 %)	27 (7.11 %)	54 (7.39 %)
Women's Bantamweight 61.2 kg	14 (3.99 %)	20 (5.26 %)	34 (4.65 %)
Women's Featherweight 65.8 kg	1 (0.28 %)	2 (0.53 %)	3 (0.41 %)
Catch Weight	13 (3.70 %)	1 (0.26 %)	14 (1.92 %)
Total	351	380	731

Note: Shares of weight classes are in parentheses.

Weight classes are also controlled in the model. These variables are collectively referred to in the model as *Weight Classes*. Fans often expect the heavier weight classes to deliver more KO/TKO [Sampson 2009]. Table 3 shows the distribution of fights by weight class. The distribution of fight categories between the two periods is identical at the 1% level except for the Catch Weight

category according to the test for homogeneity of a binomial distribution. Overall, the two periods are therefore suitable for comparison.

Table 3 also shows the proportion of women’s fights, of which there were 132 in total. There were 68 in front of an empty arena and 64 in front of the audience. Most of the fights took place at Welterweight, Lightweight, and Featherweight.

The last effect controlled for is the fixed effects (FE) of the individual fighters. These variables are collectively referred to as *Fighters FE* in the model. These variables aim to identify whether specific fighters’ ability to cause a KO/TKO or SUB. A possible role may also be played by a predisposition to receive a KO/TKO or SUB [Seifert, Shipman 2015] and could be attributed to a fighter’s unique fighting style. FE, being standard in models of this type, have been consistently employed in previous research [Bryson *et al.* 2021].

Finally, descriptive statistics of the variables used in some of the models are provided in Table 4.

Table 4. Descriptive statistics - fights

	Mean	Median	S.D.	Min	Max
Finish	0.49	0.00	0.50	0.00	1.00
Empty Arena	0.48	0.00	0.50	0.00	1.00
Odds	0.64	0.62	0.09	0.50	0.90
Gender	0.18	0.00	0.38	0.00	1.00
Empty Arena * Gender	0.09	0.00	0.28	0.00	1.00

Results

To test for effects on finishing before the time limit, at first, models are initially built, each with one independent variable, to assess zero-order effects. Specifically, the models include the variables *Empty Arena*, *Odds*, *Gender* and *Empty Arena * Gender*.

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \varepsilon \tag{1}$$

$$Finish = \beta_0 + \beta_1 \cdot Odds + \varepsilon \tag{2}$$

$$Finish = \beta_0 + \beta_1 \cdot Gender + \varepsilon \tag{3}$$

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena \cdot Gender + \varepsilon \tag{4}$$

Since the dependent variable is binary, the logit is used for estimation. The resulting coefficients are reported in Table 5.

The results demonstrate statistical significance for all variables, with a significance level of at least 10%. The effect of *Empty Arena* is positive, indicating that the absence of an audience leads to a higher frequency of finishes before the time limit. Similarly, the effect of *Odds* is also positive, suggesting that fights with a clear favourite more often result in finishing before the time limit. On the contrary, the effect of *Gender* is negative, indicating that women’s fights are less likely to have finishes before the time limit. Lastly, the effect of *Empty Arena * Gender* is negative as well, indicating that in

women’s fights without an audience, finishes before the time limit occur less frequently.

As for effect sizes, for *Empty Arena*, it is observed significant effect ($p < 0.05$) with higher ODD for finish before the time limit (Exp B – 1.148). For *Odds*, it is observed significant effect ($p < 0.01$) with higher ODD for finish before the time limit (Exp B – 1.257). For *Gender*, it is observed significant effect ($p < 0.01$) with lower ODD for finish before the time limit (Exp B – 0.787). For *Empty Arena * Gender*, it is observed significant effect ($p < 0.1$) with lower ODD for finish before the time limit (Exp B – 0.884). These results provide further confirmation of the conclusions drawn from the coefficients and their significance.

Table 5. Zero-order effects on early fight finish

	(1) Exp(B)	(2) Exp(B)	(3) Exp(B)	(4) Exp(B)
Empty Arena	0.276** (1.97)	1.148		
Odds		2.504*** (3.81)	1.257	
Gender			-0.623*** (-3.51)	0.787
Empty Arena * Gender				-0.436* (-1.80)
Const.	-0.179* (-1.81)	-1.649*** (-3.82)	0.063 (0.88)	-0.01 (-0.12)
Weight Classes	N	N	N	N
Fighters FE	N	N	N	N
Obs.	731	731	731	731

Note: z Statistics values are in parentheses. * $p < .10$.

** $p < .05$. *** $p < .01$

To examine the effect of gender on finishes before the time limit, sub-dataset models are constructed. The first sub-dataset comprises only women’s fights, while the second sub-dataset includes only men’s fights. Four models are applied to these subdatasets: the first includes only the main variable *Empty Arena*, the second to fourth include the *Odds* variable as well. In the second model, no additional variable is added, while the third model includes the *Weight class*, and the fourth model includes the *Fighters FE*.

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \varepsilon \tag{5}$$

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \beta_2 \cdot Odds + \varepsilon \tag{6}$$

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \beta_2 \cdot Odds + \beta_4 \cdot Weight\ Classes + \varepsilon \tag{7}$$

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \beta_2 \cdot Odds + \beta_4 \cdot Fighters\ FE + \varepsilon \tag{8}$$

The logit is used for estimation. The resulting coefficients are reported in Table 6.

Regarding the models for men and women separately, the models for men confirm the trends observed

in models 1 to 4, where the variables Empty * Arena and Odds are statistically significant at a significance level of at least 10%, and the directions of the dependencies are positive. In contrast, for the models for women, the variables do not appear to be statistically significant. Nevertheless, the effect of gender will be further tested in subsequent main models.

Table 6. Gender effects on early fight finish

	(5)	Exp(B)	(6)	Exp(B)	(7)	Exp(B)	(8)	Exp(B)
Gender	W		W		W		W	
Empty Arena	0.226 (0.63)	1.120	0.249 (0.69)	1.133	0.264 (0.72)	1.142	-0.028 (-0.07)	0.986
Odds			2.767 (1.44)	1.311	2.550 (1.25)	1.283	4.465 (1.42)	1.548
Const.	-0.671** (-2.55)		-2.489* (-1.93)		-2.657* (-1.87)		-4.748** (-2.25)	
Weight Classes	N		N		Y		N	
Fighters FE	N		N		N		Y	
Obs.	132		132		132		132	
Gender	M		M		M		M	
Empty Arena	0.294** (2.11)	1.158	0.287** (2.11)	1.154	0.272* (1.96)	1.146	0.410* (1.90)	1.228
Odds			2.646*** (3.86)	1.269	2.846*** (4.08)	1.292	3.409*** (3.26)	1.359
Const.	-0.077 (-0.75)		-1.760*** (-3.91)		-2.080*** (-4.46)		-2.041*** (-2.95)	
Weight Classes	N		N		Y		N	
Fighters FE	N		N		N		Y	
Obs.	599		599		599		599	

Note: z Statistics values are in parentheses. *p < .10.

p < .05. *p < .01

As for effect sizes, in women’s models, no significant effect is observed (p > 0.1). In men’s models, for *Empty Arena*, it is observed significant effect (p < 0.05) in models 5 and 6 and (p < 0.1) in models 7 and 8. The ODD for finish before the time limit is higher in all models: 5 (Exp B – 1.158), 6 (Exp B – 1.154), 7 (Exp B – 1.146), 8 (Exp B – 1.228). For *Odds*, it is observed significant effect (p < 0.01) in all models. The ODD for finish before the time limit is higher in all models: 6 (Exp B – 1.269), 7 (Exp B – 1.292), 8 (Exp B – 1.359). These results provide further confirmation of the conclusions drawn from the coefficients and their significance.

Following this, three main models are subsequently constructed to further analyze the effects. All three models contain an independent dummy variable *Empty Arena*. In addition, the second model examines the gender effect and thus an interaction term *Empty Arena * Gender* is added. The third model additionally contains dummy variables for *Weight Classes*. The fourth model contains *Fighters FE*. Here are the formulas of the models.

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \beta_2 \cdot Odds + \beta_3 \cdot Empty\ Arena * Gender + \varepsilon \tag{9}$$

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \beta_2 \cdot Odds + \beta_3 \cdot Empty\ Arena * Gender + \beta_4 \cdot Weight\ Classes + \varepsilon \tag{10}$$

$$Finish = \beta_0 + \beta_1 \cdot Empty\ Arena + \beta_2 \cdot Odds + \beta_3 \cdot Empty\ Arena * Gender + \beta_4 \cdot Fighters\ FE + \varepsilon \tag{11}$$

Since the dependent variable is binary, the logit is used for estimation. The resulting coefficients are reported in Table 7.

The resulting coefficients show that all variables are stable despite different combinations of effects. The *Odds* variable shows that if a fight has a clear favourite, it is more likely to finish before the time limit. Both the size of the coefficient and the statistical significance indicate a significant effect of this variable.

Table 7. Audience effect on early fight finish

	(9)	Exp(B)	(10)	Exp(B)	(11)	Exp(B)
Empty Arena	0.399*** (2.99)	1.221	0.272** (1.96)	1.146	0.590*** (2.82)	1.343
Odds	2.550*** (3.96)	1.263	2.789*** (4.18)	1.291	3.763*** (3.77)	1.411
Empty Arena * Gender	-0.687*** (-2.94)	0.823	-0.007 (-0.02)	0.998	-1.336*** (-4.27)	0.685
Const.	-1.810*** (-4.18)		-2.043*** (-4.37)		-2.579*** (-3.83)	
Weight Classes	N		Y		N	
Fighters FE	N		N		Y	
Obs.	731		731		731	

Note: z Statistics values are in parentheses. *p < .10.

p < .05. *p < .01

The main independent variable in all models is the *Empty Arena*. The results show that the absence of an audience has a positive effect on finishing the fight before the time limit. In models (9) and (11), the variable is significant at 1%. In model (10), it is significant at 5%.

As for effect sizes, for *Empty Arena*, it is observed a significant effect (p < 0.01) in models 9 and 11 and (p < 0.05) in model 10. The ODD for finish before the time limit is higher in all models: 9 (Exp B – 1.221), 10 (Exp B – 1.146), 11 (Exp B – 1.343). For *Odds*, it is observed significant effect (p < 0.01) in all models. The ODD for finish before the time limit is higher in all models: 9 (Exp B – 1.263), 10 (Exp B – 1.291), 11 (Exp B – 1.411). For *Empty Arena * Gender*, it is observed significant effect (p < 0.01) in models 9 and 11 and no significant effect (p > 0.1) in model 10. The ODD for finish before the time limit is lower in all models: 9 (Exp B – 0.823), 10 (Exp B – 0.998), 11 (Exp B – 0.685). These results provide further confirmation of the conclusions drawn from the coefficients and their significance.

The inclusion of *Weight class* in a model (10) has an impact on the significance of the remaining variables compared to models (9) and (11). Specifically, the statistical significance for the *Empty Arena* variable is

reduced to 5%. Consequently, the size of the coefficient and ODD are lower in a model (10). Moreover, the interaction term *Empty Arena * Gender* loses significance and its effect becomes negligible in a model (10). However, there is no significant change observed in the *Odds* variable between these models.

The use of *Fighters FE* in a model (11) has no significant effect on the remaining variables, confirming the robustness of previous models (9) and (10).

Discussion and Conclusion

This paper investigates the effect of the presence of an audience in the arena on the finishing of MMA fights before the time limit. The results indicate that fighters tend to finish fights before the time limit more frequently in the absence of an audience. However, the reasons behind this phenomenon may be diverse. Previous literature [Mesagno *et al.* 2015] suggests that choking under pressure in front of an audience could be a possible factor, affecting both the winning and losing sides. The presence of an audience may lead to hesitation and caution in the winning fighter, preventing them from delivering a decisive finish before the time limit. On the other hand, the inferior fighter might be motivated to resist their opponent longer to avoid being finished before the time limit in front of the audience. Unfortunately, for fans who enjoy finishes by KO/TKO or SUB [Fusco 2013], the presence of an audience in the tournament may result in a higher number of decisions determined by referees.

To address this issue, it is advisable to recommend fighters to undergo various psychological interventions to prepare themselves for the presence of an audience. Psychological strategies, such as those recommended in literature [Land, Tenenbaum 2012; Gröpel, Mesagno 2019], can help fighters resist choking under pressure and perform better under the influence of the audience. For instance, techniques like left-hand contraction, known to enhance stress resistance in taekwondo kicks, could prove beneficial [Beckmann *et al.* 2013]. By employing such interventions, fighters may increase their chances of delivering a victory before the time limit, irrespective of the audience's presence, leading to more decisive and entertaining finishes.

If the results are approached from the point of view of the winning fighter who was unable to deliver the finish, then the audience acts as a stress factor. This phenomenon is anchored in the literature on other sports [Wallace *et al.* 2005]. It is possible to mention, for example, soccer [Dohmen 2008], biathlon [Harb-Wu, Krumer 2019], basketball [Boheim *et al.* 2019], and baseball [Jane 2022]. However, this effect is ambiguous [Boudreaux *et al.* 2017; Jane 2022]. A close subject being investigated by Krumer [2017] on the example of judo, where the author shows the positive influence of the audience on

the fighters in the home environment. Thus, this paper suggests a rather opposite effect in combat sports.

Thanks to model (10), it is possible to see the effect of different weight classes on finishing before the time limit. The results show that Light Heavyweights and Heavyweights are more likely to finish before the time limit, which is also expected by fans [Sampson 2009]. Fewer early finishes occur in Strawweight. Coefficients are not shown in Table 7 for clarity.

Another variable examined was the effect of gender in front of an empty arena. In models (9) and (11), it appears that women without an audience finish fights before the time limit less often compared to men. In model (10), the direction of the relationship is the same, but the variable is not statistically significant. In women's fights, the opposite effect is shown compared to men. However, it is important to interpret this result with caution, as models 5 to 8 did not demonstrate a significant effect of the audience on women's fights. Nevertheless, there is some indication that the presence of the audience may lead to a higher frequency of the winner finishing her opponent before the time limit in women's fights.

In MMA, individual fighters cannot fight every week, as it takes longer to recover. So, fighters' FE may not be robust enough. Although the underlying data for this paper are from the world's largest MMA organization and most of the fighters in the dataset fought in both periods studied, confirmation of the robustness of the results on data from other organizations would be helpful. Mention can be made of ONE Championship, Bellator MMA, KSW, or Octagon MMA. While this would not solve the fighters' FE problem, it would increase the number of observations and expand the predictive value of the results.

Further future research could then explore other combat sports. After all, MMA is often described as a show business sport and so the effect of the audience may be different than in more traditional combat sports situations with a long history. The results from sports such as karate, kempo, jiu-jitsu, taekwondo, and Muay Thai may be different. This assumption is confirmed by the aforementioned Krumer [2017] using judo as an example.

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Wpływ nieobecnej publiczności na wyniki mieszanych sztuk walki podczas COVID-19

Słowa kluczowe: płęć, wydajność, stres, psychologia

Streszczenie

Wprowadzenie. Niniejszy artykuł bada wpływ obecności publiczności na wyniki w niezbadanym wcześniej środowisku mieszanych sztuk walki (MMA). W tym sporcie sportowcy mają znaczną motywację do zakończenia walki przed upływem limitu czasu. Zachęty te mają charakter finansowy, ale są również wymagane bezpośrednio przez fanów i dają zawodnikowi pewność zwycięstwa. Problem i cel. Publiczność może wpływać na wyniki sportowców, służąc jako motywator lub stresor. Niniejszy artykuł ma na celu zbadanie wpływu obecności publiczności na zdolność zawodników do ukończenia walki przed upływem limitu czasu. Materiał i metody. Wykorzystane dane pochodzą z Ultimate Fighting Championship z lat 2019-2020. Pierwszy rok był przed COVID-19 z publicznością, a drugi podczas COVID-19 bez publiczności. Modele zostały zbudowane w celu ujawnienia wpływu obecności publiczności na częstotliwość ukończenia walki przed upływem limitu czasu.

Wyniki. Wyniki pokazują negatywny wpływ obecności publiczności na ukończenie walki przed upływem limitu czasu. Jednak w przypadku kobiet wyniki nie są tak jednoznaczne. Wnioski. W artykule omówiono również interwencje, które mogą prowadzić do wyeliminowania negatywnego wpływu publiczności na wyniki.