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Unravelling the impact of the covid-19 pandemic on judo: a comparative analysis of the 2018-ec and 2020-ec championships

Desentrañar el impacto de la pandemia de covid-19 en el judo: un análisis comparativo de los campeonatos europeos de 2018 y 2020

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Abstract. An athlete's performance, though relying on the ability of the competitor, is also significantly influenced by the training time. If a sportsperson is deprived of exercising, severe consequences may arise regarding his practice as the result of such behavior. This is what occurred in the awakening of the COVID-19 pandemic where several athletes were deprived of training according to the required conditions for a high-level sport. Thus, this essay aimed to examine the various aspects of this impact. For this purpose, the effect changes in training routines on the athlete's performance/abandonment and on the combat dynamics were analyzed. Based on a quantitative analysis methodology, with descriptive and inferential analytical processes, it was considered the data obtained through the direct observation of video recordings of the combats held at the 2018 and 2020 European Championships. The results did not reveal a significant resignation of athletes from high competition but there are indications of a decrease in the number of attacks and more combat, increasing the duration of pauses and approaching the grips time (using $P<0.05$ as significance level).
Keywords: judo; COVID-19; performance analysis; combat sport; Temporal Structure of Judo Combat.

Resumen. El rendimiento de un deportista, aunque depende de la capacidad del competidor, también se ve influido significativamente por el tiempo de entrenamiento. Si se priva a un deportista de ejercicio, pueden derivarse de este comportamiento graves consecuencias para su práctica. Esto es lo que ocurrió a raíz de la pandemia de COVID-19, cuando varios deportistas se vieron privados de un entrenamiento acorde con las condiciones exigidas para el deporte de alto rendimiento. El objetivo de este estudio era, por tanto, analizar los distintos aspectos de este impacto. Para ello, se analizó el efecto de los cambios en las rutinas de entrenamiento sobre el rendimiento/abandono de los atletas y la dinámica de combate. A partir de una metodología de análisis cuantitativo, con procesos analíticos descriptivos e inferenciales, se consideraron los datos obtenidos mediante la observación directa de las grabaciones en vídeo de los combates celebrados en los Campeonatos de Europa de 2018 y 2020. Los resultados no revelaron un abandono significativo de los deportistas de alto nivel, pero sí indicios de una disminución del número de ataques, debido a un aumento de la duración de las pausas y del tiempo de aproximación (utilizando $P<0,05$ como nivel de significación).
Palabras clave: judo; COVID-19; análisis del rendimiento; deporte de combate; estructura temporal del combate de judo.

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Introduction

The COVID-19 pandemic has had a profound impact on society, leaving a lasting impression on individuals, especially the younger generation (World Health Organization - (WHO, 2020)). In terms of physical activity, the effects of this period were no exception. Alarcón et al.(2023) highlight the limitations of physical activity, even in the school environment (in physical education classes). It should be noted that this is the place where many young people have (sometimes unique) contact with the practice of sport and with a variety of sports. The authors emphasize that COVID-19 has increased a very high level of physical inactivity among people. This has several negative consequences, such as reduced energy expenditure (which increases the risk of obesity), high levels of stress and anxiety. In other words, not only has the motivational aspect and interest in certain sports been compromised, but it has also had an impact on health (both physical and psychological).

In elite sports, the effects have also been visible and researchers have been interested in the various studies reported in the scientific literature. Not only the physical and mental health of athletes (and other sports professionals such as educators and coaches), but also the training/working conditions (and the adaptations made) have been the subject of research. A study by Candra et al. (2022) examining the impact of pandemic restrictions on the psychological well-being of athletes found that participants predominantly experienced feelings of sadness and disappointment due to restrictions on their sporting activities, with some even withdrawing from competitions.

Indeed, this period, highlighted by the WHO (2020) as one of the most memorable and influential to date, has had a notable impact on both the physical and psychological levels, as well as on the training/working conditions of sports professionals. Reis et al. (2024) stress that, despite the resumption of activities, the restructuring of the sports system is likely to take several years.

As far as individual sports are concerned, although some studies have been reported on the impact of the pandemic on the lives of athletes and on changes in training methods, their significance is far from that of team sports (especially football). This justifies the need for further research in this area to help fill this gap in the scientific literature.

In fact, given the framework outlined, it was considered appropriate to carry out this research, the main objective of which is to reflect on the impact of the COVID-19 pandemic in the field of non-collegiate sports, particularly combat sports such as judo.

Corroborating what has happened in team sports, the pandemic has had an impact on young athletes and coaches

in combat sports (particularly judo). Makarowski et al. (2020) emphasize that COVID-19 has posed significant barriers to the career progression and performance of these athletes, both in physical and technical terms and in psychological terms.

Amoedo and Juste (2016) state that there is a positive correlation between perceived self-efficacy and sporting performance, and between self-esteem and sporting performance. The higher the level of self-efficacy and self-esteem, the better the athletic performance. Therefore, based on research carried out with members of the Galician Federation and the Royal Spanish Federation of Judo and Associated Sports, the authors confirm the impact that the psychological and motivational aspects of high-performance athletes have on their performance. In fact, the recognition of the negative psychological effects of the pandemic may have affected the performance of the athletes.

At the same time, in the physical and technical domain, one of the major challenges faced during the pandemic period was the lack of training partners and specific aspects of training (Andreato et al., 2020). Such limitations had a clear impact on the training/working conditions and training methodology of the athletes. Such a situation may have compromised the athletes' good physical development, which, according to Norambuena et al. (2021), increases the likelihood of successful competitive performance. What's more, communication between athletes and coaches has become limited or even non-existent. This has led to the search for solutions to monitor athletes. In some cases, the answer has been the use of technological devices that utilize online social interaction platforms (Hayes, 2022), to develop customized home training programs aimed at maintaining athletes' physical condition (De Oliveira Neto et al., 2020). These programs have proven to be valuable tools in helping elite and non-elite competitors resume normal practice (Jukic et al., 2020; Toresdahl et al., 2020; Yousfi et al., 2020). Despite the adaptations that have been made, all the restrictions on the practice of the sport, in addition to the impact on technical quality (increased susceptibility to injury), may have contributed to a reduction in the number of athletes practicing and interested in the sport. In fact, not only as a result of the above-mentioned conditions and/or others prior to the pandemic, some organizations have made efforts to make the sport more attractive, especially in highly competitive scenarios. The aim of these measures is to help judo maintain its record of increasing interest and popularity and to attract more fans and practitioners.

For example, the International Judo Federation (IJF), through its Technical Commission, has made changes to refereeing rules and competition regulations during the Rio16 and Tokyo20 Olympic cycles(Barreto et al., 2022; Ceylan et al., 2022). These efforts aimed to protect athletes' health (Reale et al., 2017) and promote the concept of "positive" judo, emphasizing the continuous pursuit of attack and scoring rather than the defensive approach associated with "negative judo," which focuses on acquiring points through penalties (*shido*) (Calmet et al., 2017; Doppelhammer et al., 2020). It is well recognized that any rule change requires technical and tactical adaptations from coaches and athletes in the context of training and competition (Dopico-Calvo et al., 2023; Samuel et al., 2020). The effects of these rule modifications in the realm of judo and their subsequent evaluation have sparked curiosity among researchers (Dopico-Calvo et al., 2022; Samuel, et al., 2020). Numerous studies have been conducted to comprehend the intricate dynamics within judo contests, investigating various aspects such as temporal structure (combat effort with approach, gripping, attack, groundwork and pause moments) (Barreto, et al., 2022), penalties (Balci et al., 2020; Kajmovic et al., 2022), offensive manoeuvres (Barreto et al., 2021), match conclusions, and the acquisition of scoring points.

Regarding judo combat phases, before establishing their grips, judo athletes undergo a captivating sequence of actions, which includes an initial approach followed by a gripping dispute—an engaging standing activity phase where competitors vie for control without firmly grasping the opponent's judogi (Calmet et al., 2010). Subsequently, the transition is made to the gripping phase, where the judoka firmly clutches the opponent's judogi with one or both hands (Calmet, et al., 2010). This multifaceted study delves into the captivating dynamics of these pre-grip stages, shedding light on the complexities of strategic positioning, tactical manoeuvring, and the psychological aspects that shape this critical phase of judo contests (Soto et al., 2020).

Before the last years of rules changes (between 2016-2022), one of the combat strategies was to acquire a score using penalties. Franchini et al. (2013) observed an increase in penalties (*shido*), disqualifications (*hansoku-make*), and scores (*yuko, wazari*, and *ippon*) exclusively in the male category when comparing the 2012 and 2013 editions of the European Championships. Furthermore, (Monteiro et al., 2019) found a significant 25% rise in combats decided in Golden Score during the 2017 Budapest World Championships, despite male combats already being four minutes long.

On the other hand, in a survey conducted by Katicips et al. (2018) involving three Paris Grand Slam (PGS) editions (2011, 2016, 2017), an increase in penalties for men in 2016 was observed, contradicting the theory of positive judo, which prioritizes scoring over penalties. Calmet et al. (2017) analyzed the World Championships of Astana 2015 and Budapest 2017, noting that while the number of *ippon* remained the same, *wazari* increased, and penalties decreased, especially in the female category, from 2015 to 2017. Additionally, Doppelhammer & Stöckl (2020) compared the impact of rules imposed in 2017/2018 by analyzing the 2015 and 2018 World Championships. Their study identified a growth in the number of combats decided by *ippon* and *wazari* for both sexes. However, this penalty decrease did not significantly affect the number of projections,

attack frequency, efficiency, *wazari* counts, and combats decided by *shido* (in regulation time or in the Golden Score), or combat duration (Doppelhammer & Stöckl, 2020).

Previous research indicates that the gripping (*kumi-kata*) time in judo combat represents the longest moment of the combat (Miarka et al., 2018). The gripping moment holds paramount importance in achieving competitive success (Calmet, et al., 2010; Kajmovic et al., 2014; Miarka et al., 2016; Soriano et al., 2019). It serves as a foundation for initiating attacks, executing techniques, and gaining control over opponents (Courel et al., 2014). Through strategic manipulation of grips, judokas can establish dominance, disrupt opponents' strategies, and create scoring opportunities (Barreto et al., 2019). Understanding the criticality of the gripping moment is key to unlocking the potential for triumph in judo competitions. In an attempt to compare two Olympic cycles, Barreto et al. (2021) analyzed competitions between 2015-2016 and 2019-2020, concluding that the time spent on the grip-approach increased in the latter epoch despite an overall decrease in the duration of combats.

While previous studies have offered diverse insights, the full extent to which rule changes have effectively promoted positive judo remains uncertain. Given this ambiguity, our current investigation aims to explore the potential adverse repercussions of the unprecedented COVID-19 pandemic on various aspects of judo combat. Therefore, the primary objective of this study is to analyze the combats held in the European Championships of 2018 and 2020. The latter, notably taking place in November of that year, marked the first major event of the season and served as the second post-confinement Olympic qualifying competition. Through this comprehensive study, we endeavour to illuminate the implications and outcomes arising from these extraordinary circumstances, offering valuable insights into the intricate relationship between rule modifications, the global pandemic, and the world of judo.

Methods

Study design

For our purpose, a thorough analysis is undertaken regarding the combats held during the 2018 and 2020 European Judo Championships. Present investigation focused on the combat time structure, as well as the scores, in order to comprehend if there are any differences in the combats' dynamics. Given the above and based on the literature review, in Figure 1 are displayed some of the topics which directed this research.

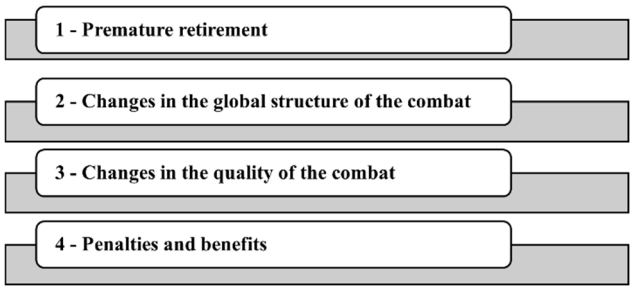

Figure 1. Research topics.

Data

Databases

In order to answer the issues conducting this project, two databases were created. In a first database, it was established a compilation of all athletes who participated in the 2016, 2018, and 2020 European championships.[1] In addition, the number of athletes who attended more than once between 2016 and 2018, and also between 2018 and 2020, was calculated as well.

On the other hand, a second database comprised the European Championships in Tel Aviv 2018 (EC-2018), the last European contest held before the first lockdown due to the COVID-19 pandemic (the European Games were held in 2019), and the EC Prague 2020 (EC-2020), the first major post-COVID Continental event of the World Circuit competitions. The database was created according to a second-by-second analysis of the available combat recordings. Likewise, following the same procedures as for Monteiro (1995), a total of 562 combats were observed and analyzed (283 combats in 2018, and 279 in 2020). Additionally, in the following section, with the intention of quantitively analyzing each combat, a detailed survey is presented regarding some of the measures that require clarification according to the scientific literature, and in order to better answer this essay's inquiries.

Measures

The following list, based on Miarka et al. (2012), resumes the established measures regarding judo combats:

- Total combat time: Overall time of the combat from the beginning of the match (hajime) until its completion (soremade).
- Effort time: Totality of time between each hajime and matte.
- Pause time: Totality of time between each matte and hajime, from the initial moment until the soremade. The indications of sonomama and yoshi, i.e. stop in a certain stage of the combat and its resumption are also considered whilst in pause time.
- Ground combat time: Totality of time in which

[1] Data obtained from https://www.eju.net/

one or both fighters characterized the work of ground techniques (newaza).

- Number of attacks: with and without a score; obtained score; obtained penalties and correspondent justification.

Research questions

The following are the main issues considered during this research process. The formulation of these questions was inspired, not only by the overview of the scientific literature explored in Section 1, but also by the measures/variables identified in the previous section.

Thus, while comparing 2016-2018 to 2018-2020, the first question requiring reflection is:

Q1 - Were there less assiduous participations from athletes in competitions between 2018 and 2020, or was it more evident between 2016 and 2018?

While focusing on the two European championships, when comparing 2018 with 2020, the following research considerations should also be raised in order to inquire: "Was there a more passive judo in 2020?"

Q2 - Compared to 2018, is the total combat time significantly higher in 2020?

Q3 - Compared to 2018, did pause time increase in 2020?

Q4 - Compared to 2018, did effort time decrease in 2020?

Q5 - Compared to 2018, how is the number of actions per combat different in 2020?

Q6 - Compared to 2018, how is the number of Golden Scores (GS) different in 2020?

Q7 - Compared to 2018, did the intensity of combats (based on the number of attacks) decrease in 2020?

Q8 - On the whole, which significant differences may be identified regarding the final results of the matches?

Statistical analysis

The statistical techniques used were mainly *t*-tests for comparison of mean values and the Mann–Whitney–Wilcoxon (MW) and Kolmogorov-Smirnov (KS) tests for comparison of distributions with MW using only the rankings of observations. In fact, as the sample is large (greater than 30) we can always invoke the central limit theorem to perform *z*-tests (they are equivalent to *t*-tests given the large sample size). In this case, as we wanted to state that one of the championships was less intense, we used one-sided tests with a significance level of 5%. Whenever the p-value is lower than this value we reject the null hypothesis, when the objective is to show the lower intensity of judo practiced in 2020. In the case of the non-parametric MW/KS tests we tried to corroborate the results of the *t*-tests where the inference is based on the means.

In addition, we performed *z*-tests for proportions that allowed us to compare the proportion of Golden-Scores between 2018 and 2020 and we further used a Chi-Squared test for homogeneity to evaluate whether the 3 most common types of results (i*ppon*, *wazari* and s*hido*) were different between the two championships.

Data were analysed using the IBM SPSS Statistics, version 28.0, Microsoft Excel for Microsoft 365 and R, version 4.3.1.

Results

Matches Sample

As mentioned in the previous section, a total of 562 contests were observed and thoroughly analyzed. Table 1 presents a summary of the sample combats examined in this study taking into consideration: the year in which the event took place, the sex and the weight category.

Table 1.
Number of matches analyzed, by sex and weight in 2018 and 2020.

	Female							
	<48	<52	<57	<63	<70	<78	>78	Tot F
2018	19	19	19	19	18	19	19	132
2020	19	20	19	18	19	19	15	129
	Male							
	<60	<66	<73	<81	<90	<100	>100	Tot M
2018	19	19	21	21	30	22	19	151
2020	19	19	22	19	21	28	22	150

Regarding Table 1 it is possible to note how the sample presents a quite even quantity between the total number of 2018 and 2020, even regarding the weight category.

Regarding the different stages of the competition (Elimination - 129, Quarter-Final 56, Semi-Final - 28, Repechage - 28, Bronze - 28 and Final - 14) are equally represented in the two championships.

Comparing European Championships - 2016-2018 to 2018-2020 (Q1)

To answer the Q1, formulated in 0, the 3 sets of athletes attending the 2016, 2018, and 2020 European championships were examined permitting to attain the following Table 2.

Table 2.
Number of athletes in the 3 championships and number of cross-over athletes 2016/2028 and 2018/2020 by weight category and sex

2016 vs 2018																
Cat	<48	<52	<57	<63	<70	<78	>78	F	<60	<66	<73	<81	<90	<100	>100	M	Tot
2016	22	27	27	28	23	18	18	163	30	31	44	33	34	27	24	223	386
2018	24	24	30	22	21	16	16	153	20	32	41	33	38	31	20	215	368
Both	9	8	11	9	8	5	10	60	8	11	20	11	17	14	13	94	154
%	41%	30%	41%	32%	35%	28%	56%	39%	27%	35%	45%	33%	50%	52%	54%	44%	42%
2018 vs 2020																	
Cat	<48	<52	<57	<63	<70	<78	>78	F	<60	<66	<73	<81	<90	<100	>100	M	Tot
2018	24	24	30	22	21	16	16	153	20	32	41	33	38	31	20	215	368
2020	19	24	24	18	23	16	12	136	23	32	35	34	30	33	22	209	345
Both	11	11	14	12	11	7	7	73	6	17	16	17	22	17	9	104	177
%	46%	46%	47%	55%	52%	44%	44%	54%	30%	53%	39%	52%	58%	55%	45%	50%	51%

From this Table, we can see that more than 50% of the athletes taking part in 2020 took part in the 2018 European Championships. However, in 2018, only 42% of the participants had also taken part in the 2016 competitions.

For the following questions, a comparison is undertaken between the European Championship of 2018 (Pre-Pandemic) and the European Championship of 2020 (Post-Pandemic). As this essay expected to verify the negative impact on the athletes' performance, consequently, it was important to execute one-sided tests whenever this meant a worse performance of the athletes in 2020 compared to 2018.

Comparing European Championships - 2018 to 2020

Comparing the total combat time (Q2)

The way the combats were analyzed and assuming that they are representative of the pre and post Covid period allows us to say that we have two samples independent of each other and with independent observations (what happens in one combat does not depend on what happened in the previous one). The variables analyzed are the same in both samples, which allows us to make a variable-by-variable comparative analysis.

To compare the combat times (Table 3) a one-sided *t*-test to mean values ($H_0: \mu_{2020} \leq \mu_{2018}$ vs $H_1: \mu_{2020} > \mu_{2018}$) must be implemented once the assumptions for its application have been verified, namely, the large size of both samples. There is statistically significant evidence (at the 5% significance level) to affirm that, the total combat time was longer in 2020 than in 2018 (t = -2.4, df = 529.88, p-value ~ 0.01). The MW/KS tests corroborate the result with a slightly higher p-value than the t-test. The distribution function for total combat time in 2020 is to the right of the distribution function for 2018 (MW p-value ~ 0.002; and KS p-value 0.028).

With the help of Table 3 it can be seen that in addition to the total combat time also the pause time and approach times to the handle are significantly higher in 2020.

For a complete analysis of this information, it is relevant to examine how the excess concerning the combat time was employed – in actions or pauses? Moreover, what about the number of moments of action and pauses? This section shows once again that combats takes longer after the COVID-19 period, mainly due to longer pause times.

Table 3.
Descriptive statistics of the time (t) of the various moments of combat in 2018 and 2020.

Variable	N	Mean	SD	Min	1ºQ	Med	3ºQ	Max
2018								
t_total	278	252.4	136.5	15	145.2	253.0	324.8	845
t_pause	278	62.6	55.0	0	24.2	50.0	84.0	345
t_aproach	278	53.6	33.5	1	28.0	48.5	73.8	173
t_grips	278	104.8	59.2	7	55.2	104.5	140.8	375
t_newaza	278	31.3	26.5	0	11.0	25.0	45.8	169
2020								
t_total	277	282.8	168.1	13	149.0	287.0	360.0	996
t_pause	277	77.1	62.5	0	30.0	69.0	107.0	377
t_aproach	277	65.6	49.6	1	31.0	57.0	87.0	289
t_grips	277	104.7	63.0	7	56.0	100.0	142.0	334
t_newaza	277	35.4	32.0	0	13.0	28.0	50.0	217

Duration of moments of action and pauses (Q3 and Q4)

To analyze the duration of action moments and pauses, the results are presented in Table 3. The pause time is longer in 2020 (*t*-test with p-value ~ 0.002, MW and KS with similar p-values ~ 0.001) just as the time of the grip approach (*t*-test with p-value ~ 0.0004, MW with p-value ~ 0.006 and KS with p-value ~ 0.01). In moments of action, it is not possible to state that in 2018 the action times were significantly longer - in both grip (*t*-test with p-value ~ 0.5, MW with p-value ~ 0.4 and KS with p-value ~ 0.5) and newaza (*t*-test with p-value ~ 0.9, MW/KS with similar p-values ~ 0.8).

In summary, considering the more passive phases of the combat, such as pauses, grip approaches, it was visible that the time is significantly longer in 2020; regarding the moments of intense physical activity (grip and newaza), there is a similarity in relation to the time of effort.

Number of moments of action and pauses (Q5)

Regarding the number of moments of action and pauses performed, see Table 4.

Unlike time, the number of pauses did not increase significantly in 2020 (p-value ~ 0.68, MW with p-value ~ .46 and KS with p-value ~.9), as well as the number of occurrences regarding the athletes' grip approach (*t*-test with p-value ~ 0.44, MW with p-value ~ 0.63 and KS with p-value ~ 0.74), revealed a similarity between the analyzed subjects. Moreover, the number of grips per combat is also not significantly greater in 2020 from the 5% level (p-value

~ 0.07, MW with p-value ~ .14 and KS with p-value ~ 0.3) as is the number of times in newaza (p-value ~ 0.07, MW with p-value ~ 0.14 and KS with p-value ~ 0.31).

We can therefore assume that the difference between the two championships in terms of time and number of actions is mainly in the times of the actions and not in the number of actions.

Table 4.
Descriptive statistics of the number (n) of actions/no actions by combat in 2018 and 2020

Variable	N	Mean	SD	Min	1ºQ	Med	3ºQ	Max
2018								
n_pauses	278	7.7	5.2	0	4.0	7.0	11.0	28
n_aproachs	278	9.3	5.3	1	5.0	9.0	13.0	31
n_grips	278	10.0	5.7	1	5.0	9.5	14.0	35
n_newazas	278	5.0	3.4	0	2.0	4.0	7.0	17
2020								
n_pauses	277	7.5	5.5	0	3.0	7.0	10.0	37
n_aproachs	277	9.4	5.9	1	5.0	9.0	12.0	38
n_grips	277	9.2	4.8	1	5.0	10.0	13.0	22
n_newazas	277	4.6	3.1	0	2.0	4.0	7.0	13

Number of Golden Scores (Q6)

Concerning Golden Scores (GS) moments, one may also compare the two championships. There is a slight increase in GS (283 combats with 47 GS in 2018 vs. 63 GS in 279 combats in 2020). Therefore, it is possible to state that the proportion of GS at the 5% significance level is considerably dissimilar in the years under study (*z*-test to proportions with p-value ~ 0.037) – higher in 2020 than in 2018.

Intensity based on the number of attacks (Q7)

Presently, it is also important to testify to the feasibility of assuming that the combats' intensity was lower in 2020 than in 2018. For this purpose, and by resorting to a comparative analysis, it was essential to examine the number of attacks per combat in Table 5.

Table 5.
Descriptive statistics of the number of attacks/min in 2018 with 2020.

Type	Year	Min.	1ºQ	Med.	Mean	3ºQ	Max.
attack_0	2018	0.0	1.5	1.9	1.9	2.3	5.2
	2020	0.0	1.3	1.7	1.7	2.0	5.6
attack_1	2018	0.0	1.9	2.4	2.5	3.0	5.2
	2020	0.0	1.7	2.3	2.3	2.8	8.0
attack_2	2018	0.0	2.6	3.4	3.6	4.4	8.2
	2020	0.0	2.4	3.2	3.4	4.1	12.4

Three different types of evaluation were taken into consideration: the average number of attacks per minute (attack_0); the average number of attacks per minute disregarding pause time (attack_1); and disregarding pause time and the time of grip approach (attack_2). Some descriptive statistics are presented in Table 5 ensued by graphical representations of boxplots for each type of attack (Figure 2)

Regarding Figure 2, the graphical depictions of the parallel boxplots (2018 and 2020), for each case (attack_0, attack_1, and attack_2), reveal that, although the boxplots display an identical variability (identical interquartile ranges), they also present a slight shift to the right of the 2018 boxplots when compared to the 2020 boxplots. In each case, the value of each of the quartiles (Q1, Median, and Q3) is higher in 2018 than in 2020 (see Table 5). This fact may lead to infer that, in 2018, the combat was conducted with greater intensity (with more attacks per minute, regardless of how they were evaluated).

For a more robust examination, this study undertook inferential analysis through the application of statistical tests. Given the large asymmetry to the right for the six probability distributions of the number of attacks (p-values ~ 0), there was a preference for performing non-parametric tests, in this case, as in the previous ones, the recommended is the Mann-Whitney-Wilcoxon test. In any case, it is possible to assert that the distribution of the number of attacks per minute, in 2018, is more directed to the right (have higher values) than the distribution regarding 2020 (MW test, p-value ~ 5.17e-06 (attack_0), (p-value ~ 0.001 (attack_1) and p-value ~ 0.025 (attack_2)). This fact validates the previous conjecture that a greater combat intensity is visible in 2018 when compared to 2020.

Again, as with the number of actions, there is a clear trend towards less intense and less spectacular combats.

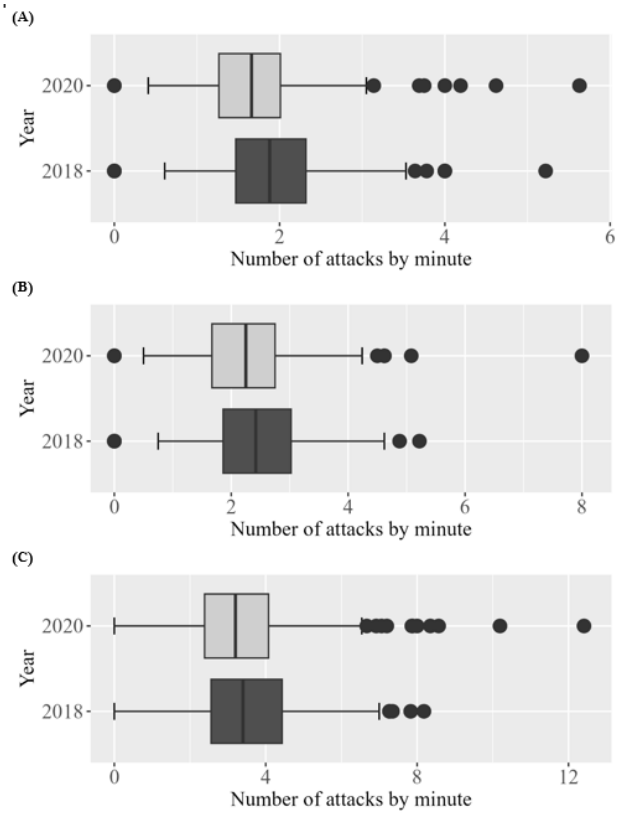

Figure 2. Boxplots of: (A) the number of attacks/minute; (B) number of attacks per minute discounting time of pauses; (C) number of attacks per minute discounting time of pauses and approach grip time.

Matches' final results (Q8)

With few exceptions, most of the combats finish with elimination by *shidos*, victory by *wazari*, or by *ippon*.

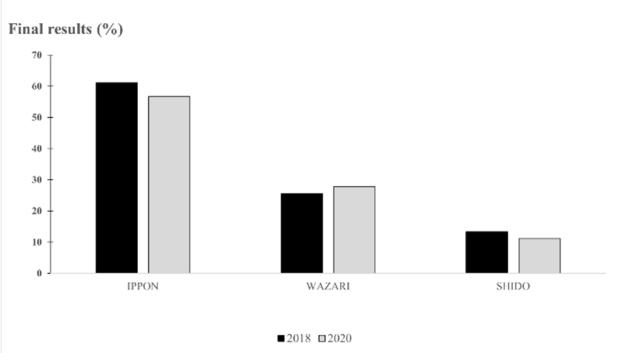

Figure 3. The final results (%) in judo combats in 2018 and 2020.

From the analysis of Figure 3, one may observe that there are no major differences in the final results' proportion in both years 2018 and 2020. In each of the three categories (*ippon*, *wazari*, or *shido*), the percentages are very similar in the two periods of study. In addition, for a more comprehensive examination, it was relevant to undertake an inferential analysis applying statistical tests, in particular, Chi-square test for homogeneity. The results demonstrated no statistical evidence of the "year" factor (2018 vs 2020) partaking in any influence on the type of outcome (p-value ~ 0.614).

Discussion

With all the modifications concerning the training routine and the preparation for competitions, as an effect of the COVID-19 Pandemic (Andreato, et al., 2020; Makarowski, et al., 2020) , it became important to understand the consequences of such events on the dynamics of judo combat. Moreover, this examination was essential to evaluate the intensity of the combats associated with: (i) the effort time and pause time; (ii) the number of attacks, and, consequently, the number of defences.

Subsequently, the obtained results notice a negative impact on the athletes' performance and attached combat dynamics. This result corroborates the facts resulting from the scientific literature and was also expected due to the drastic alterations verified in the competitor's athletic routine. Here are some determining aspects of these changes.

The international circuit ceased completely, despite the organization of internal competitions created by some teams. Nonetheless, for most countries, the national context is considerably distinct from the international reality.

Most teams and athletes could no longer collectively train for a long period, which prevented the practice of the most specific judo exercise, the *randori* (free-style sparring). As in 2017 rule changes, there was a decrease in the regular combat time for male judo from 5 to 4 minutes (IJF, 2017), it was non-expected that the 2020-EC combats have a longer average combat time compared to 2018-EC. Our combat time during E-C were longer than preceding reports (Barreto, et al., 2021; Boguszewski, 2016; Ceylan et al., 2020). Barreto et al. (2021), who indicated that combat time during 2020/21 was 206.9±101.9 seconds, shorter than in 2016, with 240.3±91.9 seconds. Boguszewski (2016) investigated the combat times in male judo at the 2016 Olympics, specifically focusing on 7 Gold Medal disputes. The average combat time observed in their study was 237.4 seconds, which closely aligns with the average combat time we obtained for the same Olympic cycle in 2016. Ceylan and Balci (2020) conducted a comprehensive analysis of 999 male combats involving elite athletes in the 2018 and 2019 World Championships. Their findings revealed an average combat time of 189.8 seconds, significantly lower than the average we obtained for the 2020 E-C. This discrepancy in combat times between our study and theirs might be attributed to the distinct characteristics of the moments, mainly considering the impact of the COVID-19 Pandemic on Judo.

Consistent with previous findings (Barreto, et al., 2021), our investigation has revealed a noteworthy observation regarding the combat times in the 2020 E-C compared to the 2018 E-C. Specifically, we found that the maximum combat time during the 2020 E-C was significantly higher than that of the 2018 E-C, indicating the existence of combats that required Golden Score with nearly double the duration of the regular combat time (i.e., 240 seconds). Our examination highlighted a remarkable increase of over 20% in combats with Golden Scores during the 2020 E-C. This aligns with Barreto et al.'s (2021) findings, which similarly reported a 21% increase in the occurrence of Golden Scores in the 2020 Olympic cycle when compared to the 2016 Olympic cycle. Ceylan and Balci (2020) also identified a considerable occurrence of Golden Scores, amounting to 20.9% in their research. However, it is essential to emphasize that despite this similarity in the occurrence of Golden Scores, their study reported a shorter combat time compared to our own.

The complete, or nearly complete, lockdown, led to a decrease in fitness levels which provoked significant increases in body weight that may have led to several of the athletes' injuries (Puga et al., 2022).

Consequently, they had more spare time without training and less time to prepare their resumption for the competitions ahead. All these reasons influence an athlete's practice on several dimensions, namely: on a technical-tactical-strategic level; on a physical level; and, especially, on a mental level. This occurs, as one may note, because confidence is not the same, regardless of the athlete's predisposition to remain motivated.

With these constraints regarding training, establishing a relationship with the results observed in this research, it is verified that in 2020: (i) the combats increased their total time, particularly, at the expense of periods of less intensity; (ii) the pause time and time without grip increased visibly. Despite belonging to the standing effort time, one must observe how the latter moment (time without grip) requires less physical energy. A strategic struggle for a controlling or dominant grip permits a lower physical exigency. Nevertheless, it is important to recognize how there is also a constant mental-cognitive effort attached to this

practice.

Regarding the number of moments of action, there were similar values in both years 2018 and 2020. This leads to the conclusion that the average time per action of pause and without grip did augment. The growth in pause time between matte and hajime may have several reasons:

- Strategic: athletes desired slower pause/effort transitions in order to have time to listen/reflect/decide.
- Physical: as a consequence of physical fatigue, athletes wished for slower pause/effort transitions in order to recover.
- Injury: when athletes are forced to stop momentarily or need further assistance.
- Refereeing: video assistance.

Additionally, the average without grip time also increased. Possible reasons may be considered in terms of strategic-physical (extra time to recover) and strategic-technical-tactical. Of the latter, it is possible to refer: (i) the extra time to work in order to reach a controlling or dominant grip; (ii) time management as a strategy for maintaining a position of advantage; (iii) time management as a strategy to exhaust the opponent and, subsequently, benefit from his technical, tactical, and physical strength.

Nevertheless, in each combat, both athletes adopted similar postures considering that there were no significant differences in the combats won by each competitor or in the application of punishment. Moreover, by analyzing the other variable, which defines the combat's intensity and the number of attacks, it was also possible to confirm a reduction in the number of attacks per useful minute (without counting pause times) in 2020, when compared to 2018. With this dynamic, one may equate that these decisions comprised:

- Physical strategy: to physically protect the athletes, with a less intensive execution of attacking actions and, consequently, a less amount of wasted energy.
- Technical and tactical strategy: additional time to prepare the attack in order to embrace the best opportunity to retaliate.

Therefore, despite having executed fewer attacks in 2020, it was visible that scores remained quite even leading to the conclusion that further attack preparation was taken into consideration. Striking at crucial moments was, consequently, a beneficial tactical decision, which may also justify the increase in time regarding the time without grip. In other words, the strengthening of patience, regarding this physical, technical, and tactical strategy (in the work of the grip) promoted the enhancement of the quality of the attack.

To conclude this reflection on the results, it should also be noted that in terms of attrition from elite competition, our data show that there was more attrition from 2016 to 2018 than from 2018 to 2020. It is likely that the greater attrition between 2016 and 2018 is due to the change in the Olympic cycle (Bradshaw et al., 2022), which is even more relevant than the possible impact of COVID-19.

Conclusion

The present study provided valuable insights into the dynamics of judo combat, particularly during the exceptional circumstances of 2020, characterized by the impact of the COVID-19 pandemic. The investigation revealed a notable reduction in the number of attacks per minute in 2020 compared to the baseline year of 2018, reflecting a discernible change in combat intensity. Athletes strategically opted for a less intensive execution of attacking actions, aiming to safeguard their physical well-being and minimize energy expenditure during combats. This calculated approach allowed them to maintain resilience and conserve vital resources. Another notable aspect was allocating additional time for attack preparation, enabling the athletes to seize the optimal moment to retaliate effectively. This emphasis on technical and tactical readiness demonstrated a strategic adaptation to the dynamic challenges posed by the pandemic.

Despite executing fewer attacks in 2020, it is evident that the competitiveness of the matches remained balanced, as indicated by the relatively even scores. This outcome suggests a deliberate focus on further attack preparation by the athletes. The strategic decision to strike at crucial moments showcased the efficacy of a tactical approach, which is corroborated by the increased time spent without a grip. The strategic modifications in combat approaches underscore the importance of thoughtful decision-making, energy management, and meticulous attack preparation in optimizing performance. As a valuable contribution to the field of sports science, this study not only illuminates the impact of external factors on sports performance but also provides practical implications for coaches and athletes. Understanding the interplay between physical, technical, and tactical strategies can empower athletes to face challenges with greater strategic acumen, ultimately leading to improved performance outcomes.

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Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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