Respuestas psicofisiológicas del toreo profesional real y simulado: estudio de un caso
Psychophysiological responses to real and simulated professional bullfighting: a case study

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Resumen. El objetivo de este estudio fue analizar variables asociadas al rendimiento del torero durante la corrida de toros y el tentadero (entrenamiento para una corrida de toros real). Los participantes fueron monitorizados durante una corrida de toros oficial y un tentadero. Los parámetros de frecuencia cardíaca se registraron con pulsómetros, la distancia recorrida, velocidades y aceleraciones se registraron con tecnología GPS y la ansiedad se evaluó con el cuestionario CSAI-2R. Se encontraron diferencias significativas en la subescala de autoconfianza entre la corrida de toros y el tentadero (P=0.037; 5.36%). Los parámetros de frecuencia cardiaca alcanzados por el torero variaron en función del toro. Se obtuvieron diferencias significativas entre el primer toro y el segundo toro en frecuencia cardiaca máxima (P=0.010; -2.69%) y TRIMP (P=0.022; -5.41%). No hubo diferencias significativas en la velocidad media alcanzada durante cada lidia, y la velocidad media que mantuvo el torero durante la corrida de toros estuvo en torno a los 2 km/h. En conclusión, la preparación física puede afectar los niveles de ansiedad precompetitiva y las características del toro podría afectar al rendimiento del torero. El registro de frecuencia cardiaca, carga mecánica y ansiedad permitiría personalizar las cargas de entrenamiento en función del rendimiento mostrado durante las corridas de toros.
Palabras clave: Ansiedad por el rendimiento, rendimiento deportivo, GPS, toro.

Abstract. The aim of this study was to analyze variables associated with the performance of the bullfighter during the bullfight and tentadero (training for a real bullfight). Participants were monitored during both an official bullfight and a tentadero. Heart rate parameters were recorded with pulsometers, distance travelled, speeds and accelerations were recorded with GPS technology and anxiety was assessed with CSAI-2R questionnaire. Significant differences were found in the subscale of self-confidence between bullfight and tentadero (P=0.037; 5.36%). HR parameters reached by the bullfighter varied depending on the bull. Significant differences were obtained between the first bull and the second bull in maximal heart rate (P=0.010; -2.69%), and TRIMPs (P=0.022; -5.41%). There were no significant differences in the average speed reached during each fight, and the average speed the bullfighter maintained during the bullfight was around 2 km/h. In conclusion physical preparation may affect pre-competitive anxiety levels and the characteristics of the bull could affect bullfighter's performance. The recording of HR, mechanical load and anxiety enables to customize training loads based on the performance shown during bullfighting.
Key Words: performance anxiety, athletic performance, GPS, bull.

Introduction

Bullfighters need to prepare in the same way as elite athletes, although it has not yet been proven that there is a direct relationship between the physical preparation of the bullfighter and his performance during the action of bullfighting, bullfighters consider it essential to improve their physical condition to be able to successfully carry out the bullfight. Bullfighting is considered an intermittent (Reyes, 2014; Zafrilla et al., 2015) and non-systematic physical activity, were bullfighters make unpredictable efforts (according to the bull behavior) during three distinct stages or tercios (Reyes, 2014; Negro Peral et al., 2006). Those actions take place at variable intensities, with varying durations, and separated by different rest periods. Therefore, an optimal physical preparation would increase the bullfighter chances to outperform the bull during bullfighting activities (Negro Peral et al., 2006). It is essential to have an ever-better physical preparation during the development of the bullfighter's professional career.

For a significant number of sports, physical training has been based on training methods derived from athletics. However, in recent decades, athletes´ physical training has taken a qualitative leap thanks to researchers who study the variables that are directly involved in the performance of each specific sport. For example, in basketball (Akenhead et al., 2014) and soccer (Castellano et al., 2011). Thus, providing more specific information regarding athlete's physical preparation.

Analyzing variables such as anxiety, heart rate (HR) behavior and movement time, which influence a bullfighter's performance in the bullring, acquire a significant role in improving bullfighters training. There are just a few studies in scientific literature which hold data on psychophysiological variables involved in bullfighting. Reyes (2004) found that during 51% of the total bullfight time, the HR of both the bullfighter and the novice (bullfighter in training) never dropped under 180 bpm. Other researchers, such as Zafrilla et al. (2015), assessed a bullfighter's HR with a heifer whilst training with a bull and in a real bullfight. The results showed that both when training with a bull and during a real bullfight, effort demands were very high, with a mean HR (HR*mean*) between 85-89% of the bullfighter´s relative maximal HR (HR*max*). These data provide information on the intensity at which bullfighters must train in order to induce cardiorespiratory adaptations.

Additionally, control of pre-competition anxiety levels is of genuine importance, because stress factors, such as spectators and responsibility, increase the level of uncertainty. According to Mateo et al. (2012) anxiety is related to the type of challenge and the level of uncertainty,

which explains why pre-bullfighting anxiety levels are high. In the practice of bullfighting, cardiac response can be influenced by physiological factors, one of which is the mental state of the bullfighter, which is closely related to HR (Zafrilla et al., 2015). Indeed, during a highly stressful period HR increases, and anxiety is one of the factors that may increase HR (Reyes, 2004; Paul & Garg, 2012). Concurrently, high levels of stress negatively affect athletes' concentration and decision-making abilities which, in turn, may negatively affects their performance (Paul & Garg, 2012; Silva et al., 2022). This also includes bullfighters because high anxiety levels can induce them to make a poor choice in their fighting style, and even put their lives at risk. However, a high level of self-confidence added to an optimal level of fitness could contribute to reducing acute emotional stress (Silva et al., 2022), since the bullfighter can perform more safely and with lower levels of anxiety (Reyes, 2004). Therefore, assessment of pre-competition anxiety, or in this case, pre-bullfight anxiety, is of key importance, as anxiety can be a differentiating factor between winning and losing (Paul & Garg, 2012; Contessoto et al., 2021). Moreover, pre-bullfight anxiety implies a significant level of uncertainty with respect to the decision-making processes, and considering that the bull's movement are unpredictable, this can result in a recipe for disaster, with fatal consequences.

In recent years, the use of global positioning system (GPS) technology has increased in a wide range of sports, helping to describe and understand the spatial context of physical activity (Pallarés & Morán-Navarro, 2012; Dellaserra et al., 2013; Ade et al., 2014); Buchheit et al., 2014; Rampinini, et al., 2015; Torres-Ronda et al., 2016; Velásquez-González et al., 2023). There are no references in scientific literature to the bullfighter's running style or type of movement. Therefore, one of the objectives of this investigation was to analyze the special context and the type of movements and intensities performed during the bullfight. As the use of GPS enables us to prescribe more precise and effective training (Dellaserra et al, 2014). Furthermore, considering that the bullfighters carry out their movements with implements whose weight ranges from 0.9 to 1.5kg in the case of the muleta, and between 4 and 6kg in the case of the cape. It was very important to know the type of movements that the bullfighters perform during the bullfight, in order to individualize the training loads, adapt them more specifically to the demands of bullfighting and ensure that the bullfighter achieves the training objectives.

Understanding the context in which the bullfighter performs, and the psychophysiological demands may help coaches and practitioners to improve the bullfighter's performance and his safety during bullfights. The aim of the study was to analyze the variables that are associated with bullfighters' performance during the bullfight and *tentadero* (training for a real bullfight), thus assisting in prescribing more specific training, consistent with the physical demands of the task.

Material and method

Participants

The participants were a professional bullfighter (age: 32.0 years old; height: 181.0 cm; body mass: 70.5 kg), and bullfighter's assistants (age: 39.5 ± 9.19 years old; height: 181.0 ± 4.24 cm; body mass: 72.35 ± 5.16 kg). The bullfighter had 12 years of professional experience at enrollment in the study where he accumulated more than 250 bullfights. At the same time, the bullfighter belonged to group B (he fought between 13 and 36 bullfights the season prior to the study). The bullfighter and the assistants training consisted of five 120-minute training sessions per week. They practiced bullfighting techniques 5 times per week and two 120-minute *tentaderos* per week. The participants were notified about the aims of the study, its design and risks. All participants gave their consent before the study began. The study was approved by the University Research Ethics Committee and was conformed to the recommendations of the Declaration of Helsinki.

Psychological Profile: Pre-competition Anxiety

The analysis tool used for the assessment of the pre-bullfight anxiety was the Competitive State Anxiety Inventory-2 (CSAI-2R) in a reduced version of 17 items. This questionnaire was divided in three subscales: Cognitive Anxiety (CA), Somatic Anxiety (SA) and Self-Confidence (SC). The participants were provided with the questionnaire 60 minutes before the bullfight, and 20 minutes before the *tentadero*. Participants were informed that the questionnaire was voluntary and that all answers were private and confidential. They were instructed not to spend too much time answering the questions and to answer according to how they felt at that particular moment.

Physiological Profile: Heart Rate

The physiological profile was measured based on HR, registering it every 5 seconds using a telemetric device (Polar Team Sport System, Polar Electro Oy, Finland). The intensity of physical activity was measured based on HR_{max}, obtained using the Tanaka equation in the case of the bullfighter's assistants, and with an incremental treadmill test in the case of the bullfighter. The HR_{max}, percentage of the HR_{max} ($\%HR_{max}$) and HR_{mean} were registered during two bullfights (first and second bull). The HR data were classified in terms of the total time the bullfighter was within three intensity zones: $>70\% HR_{max}$, $>80\% HR_{max}$ and $>90\% HR_{max}$. Data were analyzed with GPSports Team AMS software (GPSports Systems, 2006). Another analyzed variable was TRIMPs (Training Impulse) through Edwards' method. With this method, the internal training load (i.e. physiological stress) that the task imposes on to bullfighter was assessed.

Time Motion Analysis

The locomotion pattern was measured using a GPS, at a sampling frequency of 15 Hz (GPSports, GPSports

Systems). The recorded data was analyzed using GPSports Team AMS (GPSports Systems, 2006). Four zones were established to cluster the distance traveled according to displacement speed: Zone 1 = 0-6 km/h^{-1}, Zone 2 = 6.1-14 km/h^{-1}, Zone 3 = >14 km/h^{-1} and Zone 4 = >18 km/h^{-1}, total distance, maximal speed (Smax) and mean speed (Smean) during the first and second bull, both during the bullfight and the *tentadero*. Three zones were established for accelerations performed during bull 1 and bull 2: Zone 1 = 0.5-1 m/s^{-2}, Zone 2 = >1-2 m/s^{-2} and Zone 3 = >2 m/s^{-2}.

Statistical Analysis

All data were calculated using SPSS v.22 statistical software (SPSS Inc., Chicago, IL, USA) and the significance level in all cases was established at p≤0.05. The normality of data was confirmed with the Shapiro-Wilk test. The paired-samples *t* test was used to analyze the differences between groups of several dependent variables.

Results

Pre-competitive Anxiety

A greater self-confidence for the bullfighter was noted before the bullfight compared to the *tentadero* condition (P = 0.037, % of change = -5.26%). In contrast, in the assistant bullfighter group, a lower self-confidence (P = 0.019, % of change = 11.76%) and greater somatic anxiety (P = 0.017, % of change = 4.76%) was noted before the bullfight compared to the *tentadero* condition. For the remaining subscales, no statistically significant differences were found (Table 1).

Table 1.
CSAI-2 results for the bullfighter and his assitants during bullfight and tentadero.

	Bullfighter				Assistants Bullfighter			
	Bullfight (Mean±SD)	Tentadero (Mean±SD)	% Change	P-Value	Bullfight (Mean±SD)	Tentadero (Mean±SD)	% Change	P-Value
Cognitive Anxiety	10	14	40	0.09	10.5 ± 1.4	10	-4.76	0.194
Somatic Anxiety	10	9	-10	0.079	12.5 ± 0.7	8	-36	0.054*
Self-Confidence	19	18	-5.36	0.037*	17 ± 2.1	19	11.76	0.019*

*P≤0.05

Heart Rate and Time-Motion Responses

Table 2, Table 3 and Table 4 indicates the heart rate and time-motion responses of the bullfighter and the bullfighter assistants during the bullfight and *tentadero* conditions, including data for the fight with the first bull, the second bull and the two bulls combined. Statistical analysis revealed significant differences in HRmax (P = 0.010, % of change = -2.69%) and TRIMPs (P = 0.022, % of change = -5.41%) between the first and second bull in the bullfighter during bullfighting (Table 2). Similarly, significant differences were found in HRmax (P = 0.010, % of change = -2.56%) and TRIMPs (P = 0.025, % of change = -4.94%) between

the first and second bull in the bullfighter during *tentadero*. For the bullfighter, no other significant difference was found (Table 2). Significant differences were found in HRmax (P = 0.004, % of change = -0.58%), and TRIMPs (P = 0.025, % of change = 9.62) between the first and second bull in the bullfighter assistants' group during real bullfighting (Table 3). Similarly, significant differences were found in HRmax (P = 0.034, % of change- = 20.51%), DT (P = 0.024, % of change = 6.98%) and Smax (P = 0.038, % of change = 18.95) between the first and second bull in the bullfighter assistants' group during the *tentadero* (Table 3).

Table 2.
Physiological and movement results for the bullfighter during bullfight and tentadero for the first and the second bull.

		Bullfighter							
		Bullfight				Tentadero			
		First Bull	Second Bull	% Change	P-Value	First Bull	Second Bull	% Change	P-Value
Heart rate (bpm)									
HRmax (bpm)		186	181	-2.69	0.010*	160	156	2.56	0.010*
%HRmax (%)		96.4	93.8	-2.70	0.012*	82.9	80.8	-2.53	0.012*
HRmean (bpm)		165	153	-7.27	0.026*	126	124	-1.59	0.008*
>70%	(mm:ss)	21:16	16:25	-22.81	0.082	9:21	9:52	5.53	0,017*
	(%)	92.4	80.1			58.7	62.2		
>80%	(mm:ss)	17:27	13:27	-22.92	0.082	1:42	0:12	-80.36	0,437
	(%)	75.8	52.6			10.7	1.3		
>90%	(mm:ss)	8:49	4:11	-52.55	0.219	0:00	0:00	0.00	0,205
	(%)	38.3	16.6			0	0		
TRIMPs		92.5	87.5	-5.41	0.022*	40.5	38.5	-4.94	0.025*
Displacement distance (m)									
TD	(m)	829.1	985.7	18.89	0.055	663.6	405.9	-63.48	0.151
Zone 1	(m)	646.3	659.4	2.03	0.006*	427.2	285	-33.29	0.127
(0-6 km/h^{-1})	(%)	77.9	66.9			64.4	70.2		
Zone 2	(m)	160.2	280.8	75.28	0.170	236.3	120.9	-48.84	0.202
(6.1-14 km/h^{-1})	(%)	19.3	28.5			35.6	29.8		
Zone 3	(m)	22.6	45.5	101.32	0.207	0	0	0	0
(> 14.1 km/h^{-1})	(%)	2.7	4.6			0	0		
Zone 4	(m)	8.5	1	88.24	0.584	0	0	0	0
(> 18 km/h^{-1})	(%)	1	0.1			0	0		
Speed (km/h^{-1})									

Smax	20	18	10	0.054	13.9	14	0.72	0.023*
Smean	2.2	2.3	4.54	0.344	2.2	1.4	36.36	0.795
Acceleration (m/s⁻¹)								
Zone 1	55	42	18.21	0.94	32	21	-61.23	0.15
Zone 2	8	13	2.06	0.139	21	15	-1.023	0.133
Zone 3	7	11	39.4	0.121	2	9	64	0.319

*P≤0.05

Table 3.
Physiological and movement results for the bullfighter assistants during bullfight and tentadero for the first and the second bull.

		Bullfighter Assistants							
		Bullfight				Tentadero			
		First Bull (mean ± SD)	Second Bull (mean ± SD)	% Change	P-Value	First Bull (mean ± SD)	Second Bull (mean ± SD)	% Change	P-Value
Heart rate									
HRmax (bpm)		172 ± 6	171 ± 7.07	-0.58	0.004*	125 ± 32	156 ± 13.44	-20.51	0.034*
%HRmax (%)		95.29 ± 0.23	94.87 ± 7.26	-0.46	0.005*	69.33 ± 20.07	86.62 ± 4.39	24.94	0.068
HRmean (bpm)		135 ± 20	122 ± 7.78	-9.63	0.035*	110 ± 30	122 ± 28.99	-9.84	0.031*
>70%	(mm:ss)	10:36 ± 8:41	11:48 ± 1:47	11.32	0.034*	4:34 ± 9:05	5:29 ± 7:09	20.07	0.059
	(%)	51.05 ± 13.36	42.1 ± 0.71			26.4 ± 27.6	26.35 ± 21.6		
>80%	(mm:ss)	7:58 ± 7:18	7:06 ± 4:10	-10.88	0.037*	3:20 ± 4:42	4:09 ± 3:16	24.50	0.071
	(%)	41.75 ± 21.56	22.85 ± 9.12			17.55 ± 24.8	8.2 ± 11.6		
>90%	(mm:ss)	4:49 ± 4:09	2:58 ± 4:12	-38.41	0.151	0:47 ± 1:05	0:00 ± 0	-100.00	0.528
	(%)	22.45 ± 15.77	11.9 ± 16.82			4.1 ± 5.8	0 ± 0		
TRIMPs		59.87	65.63 ± 8	9.62	0.025*	27.75 ± 32.17	33.5 ± 37.5	20.72	0.052
Displacement Distance (m)									
TD	(m)	371.15 ± 118.44	116.50 ± 8.34	-68.61	0.309	690.45 ± 136.97	642.25 ± 130.32	6.98	0.024*
Zone 1	(m)	218 ± 24.89	91.8 ± 9.48	-58.89	0.25	505.65 ± 83.51	382.15 ± 91.43	-24.42	0.089
(0-6 km/h⁻¹)	(%)	60.75 ± 12.65	78.70 ± 12.66			73.45 ± 2.48	59.25 ± 2.19		
Zone 2	(m)	143.05 ± 103.17	20.55 ± 1.43	-85.63	0.417	181.50 ± 48.79	235.20 ± 36.20	29.59	0.081
(6.1-14 km/h⁻¹)	(%)	36.10 ± 16.12	19.50 ± 0.14			26.10 ± 1.84	22.45 ± 18,45		
Zone 3	(m)	9.65 ± 8.98	1.95 ± 2.75	79.79	0.504	3.15 ± 4.45	24.85 ± 2.76	688.9	0.44
(> 14.1 km/h⁻¹)	(%)	3.15 ± 3.46	1.75 ± 2.47			0.4 ± 0.57	3.95 ± 0,35		
Zone 4	(m)	0 ± 0	0 ± 0	0	0	0 ± 0	0 ± 0	0	0
(> 18 km/h⁻¹)	(%)	0 ± 0	0 ± 0			0 ± 0	0 ± 0		
Speed (km/h⁻¹)									
Smax		15.40 ± 0.57	12.85 ± 2.33	16.56	0.089	14.25 ± 0.64	16.95 ± 0.64	18.95	0.038*
Smean		1.25 ± 0.35	0.4 ± 0	212.5	0.087	1.75 ± 0.35	1.5 ± 0.28	14.28	0.874
Acceleration (m/s⁻¹)									
Zone 1		15 ± 6	5.5 ± 1	-61.23	0.344	47 ± 9.9	25.5 ± 0.7	18.21	0.199
Zone 2		10.5 ± 9	2 ± 3	-1.023	0.5	20 ± 4.2	12.5 ± 6.4	2.06	0.179
Zone 3		12 ± 10	2 ± 0	-83.33	0.5	8 ± 8.5	9.5 ± 3.5	39.4	0.022*

*P≤0.05

Table 4.
Physiological and movement results for the bullfighter and the bullfighter assistants during the bullfight and tentadero**.

		Bullfighter				Bullfighter assistants			
		Bullfight	Tentadero	% Change	P-Value	Bullfight	Tentadero	% Change	P-Value
Heart rate									
HRmax (bpm)		186	160	-13.98	0.050*	172 ± 7	156 ± 13	-9.30	0.033*
%HRmax (%)		96,4	82.9	-14.00	0.052*	95.3 ± 7.26	86.63 ± 4.39	-9.10	0.034*
HRmean (bpm)		159	125	-21.38	0.079	129 ± 6	116 ± 29.70	-10.08	0.037*
>70%	(mm:ss)	37:41	19:13	-49.00	0.2	22:24 ± 6:53	10:03 ± 13:13	-55.13	0.232
	(%)	77.83	53.38			46.68 ± 14.36	27.64 ± 36.3		
>80%	(mm:ss)	30:54	1:54	-93.85	0.462	15:03 ± 3:08	5:24 ± 7:38	-64.12	0.39
	(%)	63.82	5.28			31.37 ± 6.56	15 ± 21.2		
>90%	(mm:ss)	13:00	0:00	-100.00	0.502	7:48 ± 0:06	0:47 ± 1:05	-89.96	0.439
	(%)	26.85	0			16.25 ± 0.19	2.66 ± 3		
TRIMPs		180	79	-56.11	0.241	125.5 ± 25.8	61.25 ± 69.7	-51.00	0.216
Displacement Distance (m)									
TD	(m)	1814.8	1069.5	-41.07	0.161	1332.7 ± 6.65	490.15 ± 113.63	-63.22	0.276
Zone 1	(m)	1305.7	712.2	-45.45	0.183	887.8 ± 7.92	309.8 ± 15.41	-65.10	0.287
(0-6 km/h⁻¹)	(%)	71.95	66.59	-7.45		66.62 ± 0.93	63.6 ± 13.15	-4.53	
Zone 2	(m)	441	357.2	-19.00	0.068	416.85 ± 12.80	116.2 ± 100.83	-72.12	0.329
(6.1-14 km/h⁻¹)	(%)	24,3	33.39	37.41		31.27 ± 0.80	32.41 ± 13.07	3.65	
Zone 3	(m)	68.1	0	-100.00	0.519	24.6 ± 12.80	11.6 ± 6.22	-52.85	0.254
(> 14.1 km/h⁻¹)	(%)	3.75	0	-100.00		1.85 ± 0.24	2.58 ± 1.87	39.46	
Zone 4	(m)	9.5	0	-100.00	0.647	0 ± 0	0 ± 0	0	0.205
(> 18 km/h⁻¹)	(%)	0.52	0	-100.00		0 ± 0	0 ± 0	0	
Speed (km/h-1)									
Smax		20	13.95	-30.25	0.143	16.95 ± 0.64	15.4 ± 0.57	-9.14	0.055
Smean		2.2	1.8	-18.18	0.605	1.63 ± 0.18	0.83 ± 0.59	-49.08	0.814
Acceleration (m/s-1)									
Zone 1		97	56	-42.27	0.174	72.5 ± 11	20.5 ± 5	-71.72	0.339
Zone 2		21	36	71.43	0.161	32.5 ± 2	12.5 ± 6	-61.54	0.295
Zone 3		18	34	88.89	0.189	17.5 ± 5	14 ± 10	-20.00	0.1

*P≤0.05; **: values obtained during the fights with the first and second bull combined.

Discussion

The main objective of this research was to analyze heart rate, time-motion characteristics and pre-competition anxiety in a professional bullfighter and bullfighter assistants, as well as to compare these variables according to the type of bullfighting (i.e. real vs. *tentadero*). This investigation is the first to study time-motion analysis and external training load in professional bullfighting.

The levels of somatic anxiety (table 1) were 10% higher during the bullfight compared to the bullfighter, and 36% higher among the bullfighter's assistants. These data suggest that the change in the level of somatic anxiety between a real bullfight and a bullfight is smaller among professional bullfighters. Self-confidence levels were 5.36% higher before the bullfight than before the bullfight, while the bullfighter's assistant's self-confidence levels were 11.76% lower before the bullfight than before the bullfight. Considering that the level of physical preparation of the bullfighter was higher than that of the subordinates, and that physical preparation is closely related to confidence and self-confidence (Reyes, 2014), the greater physical preparation of the bullfighter may have positively affected their level of self-confidence before the bullfight compared to less trained helpers, allowing a reduction in acute stress, probably with a favorable impact on their bullfighting performance.

Considering that there is no previous analysis of pre-competition anxiety levels in professional bullfighters, we compared our results with those from other sports. For example, Mateo et al. (2011) who studied BMX cyclists, obtained scores in the CSAI-2R similar to those found in the three subscales of pre-competitive anxiety among bullfighters. However, Morales et al. (2013) observed different results, although they only recorded pre-competition somatic anxiety markers in swimmers. As somatic anxiety is related to physiological markers of anxiety, the results of this subscale differ in several factors compared to our findings, such as the rate of uncertainty, the task type (Mateo et al., 2011), experience and location (Reyes, 2014). We observed that the bullfighter did not show statistically significant differences for subscales of cognitive anxiety and somatic anxiety, but cognitive anxiety was 40% higher before *tentadero* compared to the real bullfight. Although we might expect greater cognitive anxiety before the real bullfight compared to the *tentadero*, it should be noted that the *tentadero* was performed prior to one of the most important periods in the bullfighting season, which may well increase cognitive anxiety levels.

The bullfighter HR*max* was 13.98% higher during real bullfight compared to *tentadero*. Significant differences were also observed for HR*max* by the bullfighter between the first and second bull in the bullfight, and during the *tentadero*. Differences were also found in the group of bullfighter assistants during the bullfight, and during the *tentadero*. Thus, these results show that the maximum intensity reached (HR*max*) differs according to the bull and the type of bullfight, since the type and behavior of the bull influences the

bullfighter's strategy in the fight, which, in turn, influences the physical performance of the bullfighter. Moreover, during the real bullfight with the first bull, the bullfighter stays >90% HR*max* during ~9 minutes, or 38.3% of the total bullfight time. For the group of bullfighter assistants, the value was lower (~4 minutes; 22.45% of the total time). During the second bull, the bullfighter accumulated ~4 minutes (16.6% of the total time), and the bullfighter assistants ~3 minutes (11.9% of the total time) >90% HR*max*. The total time accumulated >90% HR*max* during the bullfight was 13 minutes (26.85%) for the bullfighter and ~8 minutes (16.25%) for the bullfighter assistants. These data are lower than those presented by Reyes (2004), who claimed that bullfighters' and novices' bullfighters HR stays above 180 bpm during 51% of the fight. In the case of our bullfighter, these data show that his HR stayed >93% HRmax (180 bpm) for 27% of the whole fight. Independent from the difference between our findings and those from Reyes (2004), the results suggest that bullfighting is an intense activity, with important cardiovascular demands, probably requiring a high aerobic fitness. Particularly, our novel findings suggest that such demands are greater for the bullfighter compared to his assistants, posing greater demands on an adequate physical fitness preparation for professional bullfighters.

Moreover, >63.0% of the total bullfight time, the bullfighter reported an intensity >80% HR*max*. Considering the anaerobic threshold between 80-90% of the HR*max* (Pallarés & Morán-Navarro, 2012), the bullfighter spent most of the bullfight above his anaerobic threshold. The bullfighter assistants, however, spent only ~31.0% of the total bullfight >80% HR*max* (Table 4), and only ~15% of the total *tentadero* time >80% HR*max*. Further, during the first bull in the bullfight, the bullfighter achieved 165 bpm (85.49% of his HR*max*), similar to Zafrilla et al. (2015), who stated that bullfighters reach a HR*mean* of 85-90% relative to HR*max*. Reyes (2004) recorded a HR*mean* of 137 bpm for the bullfighter during the *tentadero*, higher values to those obtained in the present study during the first bull (124 bpm, 64.25% HR*max*) and second bull (125 bpm, 64.77% HR*max*).

Comparing HR measurements during the first and the second bull, we found that it accumulated more time to the 90, 80 and 70% of the HR*max* during the first bull (table 2). This makes the internal load (TRIMPs) significantly lower during the second bull (5.41%) and shows that the HR behaves differently depending on the type of bull, the development of the fight and even the type of livestock used.

Regarding the displacement variables during a bullfight, no significant differences were found between bullfighting during a bullfight and a *tentadero*. This would show that the *tentadero* could be a situational and specific context for training the displacement variables in the bullfighter. At the same time, significant differences were found in the displacement variables between the bulls fought in the ring, both in the bullfighter and in the assistant. Within the same bullfight, there may be differences between one bull and

another because there are many uncontrollable circumstances, since they depend on the behavior of the animal. In this case, the results of the study showed significant differences in the displacement variables of the bullfighters and assistant bullfighters between one bull and another during the bullfight and the *tentadero*. What could justify the idea that the performance of the bullfighters will be different in each bull due to the unpredictable behavior of the animal. More studies with larger samples are needed to provide more solid arguments for this idea.

Another relevant potential practical application derived from the current results deals with training specificity. The data obtained during the bullfighter's performance in the bullfight may be used to program its aerobic power training sessions. In addition, given the intermittent nature of this activity, an interesting approach for the development of this quality could be high-intensity interval training, where the bullfighter must accumulate 13 minutes at ≥90% HR*max* in order to reproduce physiological demands observed in the bullfight. However, following the principle of specificity to develop this quality through a specific bullfighting activity, is very difficult. Moreover, the total time the bullfighter spent at ≥90% HR*max* during *tentadero* was zero. Considering that *tentadero* is the most specific training tool for a bullfighter, in order to improve aerobic power using specific training approaches, future research in this area is needed.

Conclusion

In conclusion, Anxiety levels and the internal and external load are higher during a bullfight compared to *tentadero*. Considering that *tentadero* is the most specific training tool for a bullfighter, in order to improve the bullfighter physical fitness using specific training approaches, future research in this area is needed. Anxiety levels measured before the event for the bullfighter and his assistants were higher in the assistants than in the bullfighter, which could be accounted for by differences in the level of training between the bullfighter and his assistants. During the third part of the bullfight, the bullfighter's HR is usually ≥93% HR*max* for several minutes (~ 13min), which shows the high levels of physiological stress endured during a bullfight, as well as the need for more effective training in order to optimize performance at a central level. The novelty of including the recording of movement parameters through the use of GPS shows the type of movement that bullfighters perform in bullfighting, demonstrating that both the subaltern and the bullfighter spend most of the time (~70%) walking or holding a posture ~ 2%, which could help demonstrate that high cardiac stress could be due to the addition of psychological parameters with the mechanical factors resulting from the handling of the *cape* and *muleta* during the bullfight.

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