

1 Article

2 Characterization of Raid Hipico Uruguayo Competencies by 3 Ride Type (2007-2018): Causes of Death and Risk Factors

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Simple Summary: The aim of this study was to characterize the RHU competencies according to the distance (short vs. long), causes of deaths and associated risk factors. The study population comprised 16856 horses that participated in RHU rides from 2007 to 2018. In the entire period, there were 99 fatalities. The percentage of inexperienced horses and those who completed the ride was greater in short races than in long races. In both types of rides, more horses died during than after the ride and inexperienced horses were more likely to be dead than horses with prior experience in the sport. Short rides were associated with increased risk of sudden death, while long rides were associated with increased risk of metabolic death.

Abstract: The Raid Hipico Uruguayo (RHU) is the oldest endurance sport in Uruguay. However, despite 80 years of racing, there are no studies to characterize this type of competition, explore rates and causes of death and identify risk factors associated. The aim was to characterize the Raid Hipico Uruguayo (RHU) competencies according to the distance (Short [SR, 60km] vs. Long [LR, 80-115km]), the causes of deaths and the

37 associated risk factors. The study population comprised horses (n=16856) that participated in RHU
38 rides from 2007 to 2018. LR were more frequent than SR (p<0.001). The average speed of winners
39 was higher in SR (32.12 km/h) than in LR (28.14 km/h) (p<0.001). There were 99 fatalities (5.9 per
40 1000 starts), of which 68 were euthanasias. SR had greater frequency of high comfort index (CI =
41 Temp [°F] + Humidity [%]) than LR, and LR had greater frequency of low CI than SR (p<0.001).
42 The percentage of inexperienced horses and those who completed the ride was greater in SR than
43 in LR (p<0.001). In both types of rides, more horses died during than after the ride and
44 inexperienced horses were more likely to suffer fatalities than horses with prior experience in the
45 sport (p<0.05). The SR were associated with increased risk of sudden death, while LR were
46 associated with increased risk of metabolic death. The high fatality index shown in this work
47 warrants urgent investigation in this sport to minimize mortality associated with RHU-specific
48 diseases.

49 **Keywords:** horse; fatalities; comfort index; experience; equine; animal welfare
50

1. Introduction

Endurance equestrian sports have a long history, but it has experienced great growth in recent decades, mainly FEI endurance. As described by the FEI, "Horsemanship and Horse welfare are the core of endurance riding. Endurance is a test of the Athlete's ability to manage the Horse safely over an Endurance course. It is designed to test the stamina and fitness of the Athlete and Horse against the track, distance, terrain, climate, and clock, without compromising the welfare of the Horse" 1.

Because metabolic disturbances and deaths occur more frequently than in any other type of equestrian discipline, all equine resistance sports have a strict veterinary control that ensures the health of equine competitors 1, 2. A series of veterinary inspections and examinations are established in the interest of the health, safety and welfare of the horse in the competition. Only competitors whose horses have passed all the inspections and examinations are entitled to be classified in the final list of results 1, 3.

Elimination rates appear to have increased over recent years, which is a source of concern for the sport's ethics and image. Main reasons for elimination are lameness and metabolic disturbances, associated with dehydration and electrolyte disturbances, and with substrate depletion in active muscle fibers. Moreover, there are severe consequences of these metabolic derangements, including heat stroke, rhabdomyolysis, colic, kidney and liver insufficiency, laminitis, and disseminated intravascular coagulation 2, 4.

The Raid Hipico Uruguayo (RHU) was the first endurance sport in Uruguay. This sport dates from 1944 and since then, rides have been regulated by the Uruguayan Equestrian Federation (FEU). It is the most popular and typical equestrian discipline of Uruguay, with some unique characteristics. Ride distances vary from 60 to 115 km and according to this FEU has determined two categories: short rides (60 km) and long rides (80-115 km), all of which are divided in only 2 phases, being the first phase of long duration (2/3 of the total distance). Winning horses average speeds from 25 to 37 km/h, reaching top speeds of 50 km/h. The winning horse is the first to cross the finish line and meets subsequent veterinary requirements. For the rest of riders, the cut-off time of crossing the finish line is 45 minutes after the winning horse arrives 3.

The competitions take place on flat terrain with mostly hard surfaces and the minimum weight of the riders should be 85 kg. Horses and riders can compete in any ride regardless of their previous experience. Horses are examined by official veterinarians before the ride, after the first phase and at the end. Veterinary control after the first phase is performed 20 minutes after the arrival of the horse, and once passed, horses must wait a 40 min compulsory rest period before starting the last phase. Horses are eliminated from the ride if veterinarians consider their metabolic status or orthopedic condition not to be adequate to enable them to continue the ride 3. Sixty-one percent of the participants do not finish the ride due to lameness or metabolic reasons 5, which can sometimes lead to fatalities.

From the point of view of health and welfare, the death of equines during or after competition is a major concern for vets, riders, organizers, and for spectators. Studies on the causes of death in sports horses are scarce and mostly refer to racehorses, being the main causes sudden death 6, 7 and catastrophic musculoskeletal injury 8, 9.

96 Fatalities during endurance exercise are recognized as a consequence of prolonged
97 exercise, but data documenting incidence and causes are very limited. Balch et al, (2019)
98 reported 127 fatalities out of 335456 starts (0.28 fatalities per 1000 starts) during the
99 period 2002 to 2018. According to Balch et al, (2019), 77% of deaths were attributed to the
100 high demands of endurance exercise (leading to severe muscle cramping and exhaustion
101 and mostly attributable to acute abdominal pain) and 33% due to injuries unassociated
102 with the demands of endurance exercise (such as falling off a cliff or the trail, kick
103 injury). In addition, the risk of death increased with the distance traveled (0.12, 0.35 and
104 1.48 fatalities per 1000 starts in rides of 48, 80 and 160 km, respectively) 10.

105 Although this sport (RHU) has been carried out in Uruguay for several decades,
106 there are no reports characterizing the ride conditions, as well as the causes of death and
107 their risk factors. Therefore, the aim of this study was to characterize the RHU
108 competencies according to the distance (SR vs. LR), the causes of deaths and the
109 associated risk factors.
110

111 2. Materials and Methods

112 The study was carried out with the endorsement of the FEU, guaranteeing
113 confidentiality regarding the names of the horses and owners.

114 2.1. Data collection and studied variables

115 The study population comprised 16856 horses that participated in RHU rides from
116 2007 to 2018. All rides were contested annually between the months of March to
117 December.

118 The information obtained was entered into a computerized database, and each
119 RHU ride was assigned a unique identification number. The database included the
120 temperature and humidity, ride type and length, number of horses that started, number
121 of eliminated and retired horses (total, by phases and reason), number of inexperienced
122 horses (no RHU racing experience), number of horses that completed the ride and
123 average speed (km/h) of each phase (phase 1 and 2) and average speed of the winning
124 horse in finish line. If a variable was not recorded, the variable was assigned a value of
125 not available. Reports with incomplete data for more than two variables were not
126 included in the study. When fatalities occurred, the cause of death was recorded and it
127 also was if it occurred during or at the end of the ride. To establish the cause of death,
128 necropsy examinations by official veterinarians were performed on all dead equines. All
129 data was obtained from FEU reports.

130 2.2. Variable categorization

131 Comfort index (CI) was calculated by the sum of the temperature in Fahrenheit
132 degrees and the relative humidity as a percentage 11. CI was classified into three
133 categories: low (CI <130), medium (CI 130-150) and high (CI >150). Ride types were
134 classified by the length into two categories according to the FHU designation: short ride
135 (SR: 60 km) and long ride (LR: 80-115 km). Causes of death were classified in four
136 categories 9: metabolic conditions (colic, exhausted equine syndrome, disseminated

137 intravascular coagulation), catastrophic musculoskeletal injuries (defined as horses that
138 died or were euthanized due to severe acute bone fractures that carry a poor clinical
139 prognosis), sudden death (defined as acute death in a closely observed and previously
140 apparently healthy animal) and accidental.

141 Additionally, the place of the race where the death occurred was classified as
142 during the ride (1st phase -2nd phase) or after the ride (24 hours after the finish of the
143 ride) to know if the horses that suffered fatalities completed the course or not.

144 2.3. Statistical analysis

145 Descriptive analyses (mean and standard deviations or percentage values) were
146 calculated for the variables CI, horse experience, completed ride, speed (phase 1, phase 2
147 and average), overall fatalities, cause of death and ride type. Statistical differences by
148 ride type were calculated using a Chi-squared test or Fisher's test or Wilcoxon rank sum
149 test. Screening of all exposure variables for overall fatalities (Live/Death) were
150 performed separately using univariable Logistic Mixed Model analysis. Only variables
151 with $p < 0.2$ were considered for inclusion in the multivariate Logistic Mixed Model
152 analysis. In both analyses, all variables were considered fixed effects and the ride was
153 considered as a random effect. The multivariate models were built using a forward
154 selection procedure whereby variables with a Wald-test $p < 0.05$ were retained in the
155 model. P-values of less than 0.05 were considered statistically significant. All analyses
156 were performed in R (Version 4.2.2, 2022) and RStudio (version 2022.12.0 Build 353) 12 .

157 3. Results

158 From a total of 702 RHU competitions taking place between 2007-2018, there was a
159 threefold greater frequency ($p < 0.0001$) of LR (509, 42 rides per year) than SR (193, 16
160 rides per year). There were 16856 horse starts, of which the number of horses was also
161 greater in LR than in SR (Table 1, $p < 0.0001$). The average of horses competing per ride
162 was 22 in SR and 29 in LR. Overall, 40.5% of the horses completed the ride, 43.1% were
163 not able to complete the course due to metabolic reasons, 12.3% did not complete
164 because of lameness, while 4.1% of the horses were retired from the ride by rider
165 decision without commitment to the horse's health or welfare. The average speed of the
166 winning horses was 28.1 km/h and 32.1 km/h (Table 1), with maximum and minimum
167 speeds of 32.6 km/h and 20.3 km/h for LR and 35.9 km/h and 25.5 km/h for SR. The
168 highest average speed in each phase and the average speed of the winning horse were
169 recorded in SR (Table 1).
170

Table 1. Characteristics of competition by ride type over 702 Raid Hipico Uruguayo (RHU) rides between competition seasons 2007-2018 in Uruguay.

Variable	N	Competition by ride type		p-value ¹
		Short (60km) N = 4,030	Long (80-115km) N = 12,826	
Comfort Index, n (%)	15628			<0.001
<i>Low</i>		842 (23%) a	3274 (27%) b	
<i>Medium</i>		1683 (46%)	5407 (45%)	
<i>High</i>		1134 (31%) a	3288 (27%) b	
<i>Unknown</i>		371	857	
Experience, n (%)	14124			<0.001
<i>Inexperienced</i>		1754 (52%)	3511 (33%)	
<i>Experienced</i>		1641 (48%)	7218 (67%)	
<i>Unknown</i>		635	2,097	
Completed ride, n (%)	16856			<0.001
<i>Yes</i>		1820 (45%)	5,001 (39%)	
<i>No</i>		2210 (55%)	7825 (61%)	
Speed Phase 1, (kmhr-1)	16816	31.97 (1.49)	28.24 (1.32)	<0.001
Speed Phase 2, (kmhr-1)	16816	32.7 (3.1)	28.1 (2.4)	<0.001
Average Speed, (kmhr-1)	16856	32.12 (1.61)	28.14 (1.38)	<0.001
Overall fatalities, n (%)	16856			0.049
<i>Live</i>		3998 (99%)	12759 (99%)	
<i>Death</i>		32 (0.8%)	67 (0.5%)	
Causes of Death, n (%)	99			<0.001
<i>Accidental</i>		2 (6.2%)	1 (1.5%)	
<i>Catastrophic</i>		11 (34%)	33 (49%)	
<i>Metabolic</i>		5 (16%) a	30 (45%) b	
<i>Sudden</i>		14 (44%) a	3 (4.5%) b	

¹Pearson's Chi-squared test; Wilcoxon rank sum test; Fisher's exact test. Speed is expressed in mean (SD). Different uppercase letters within a row indicate significant differences (P<0.05).

Over the 12-year study period, there were 99 fatalities, and 68 of these horses were euthanized. All the euthanasias were performed with a rigorous criterion evaluating the future life and the suffering of the horse. The risk of fatality over the entire period was 5.87 per 1000 starts. The average number of deaths per year were 8.25 and did not differ

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over the years studied. The risk of fatality was significantly greater ($p=0.05$, odd ratio=1.52) for participation in SR (7.9 fatalities per 1000 start) than in LR (5.2 fatalities per 1000 start) (Table 2). There were significant differences in causes of death by ride type (Table 1). Short rides were associated with greater proportion of sudden death and LR were associated with greater proportion of metabolic death (Table 1). Catastrophic injuries occurred in a high proportion in both ride types (Table 1). Of the total deaths for metabolic reasons, 24 (69%) of the fatalities developed acute abdominal pain, 7 (20%) equine exhausted syndrome and 4 (11%) disseminated intravascular coagulation.

CI varied with the type of ride, SR had a greater frequency of high CI in comparison to LR; and LR had a greater frequency of low CI than SR, while there were no differences between ride type for the medium CI (Table 1). However, when CI was evaluated separately for each ride type, CI did not represent a significant risk factor for death in either ride type (table 2).

Table 2. Characteristics of overall fatalities by ride type over 702 Raid Hipico Uruguayo (RHU) rides between competition seasons 2007-2018 in Uruguay.

Variable	Short race			Long race		
	Live, N = 3,998	Death, N = 32	p-value ¹	Live, N = 12,759	Death, N = 67	p-value ¹
Comfort Index, n (%)			0.60			0.20
<i>Low</i>	834 (23%)	8 (26%)		3,261 (27%)	13 (21%)	
<i>Medium</i>	1667 (46%)	16 (52%)		5381 (45%)	26 (42%)	
<i>High</i>	1127 (31%)	7 (23%)		3265 (27%)	23 (37%)	
<i>Unknown</i>	370	1		852	5	
Experience, n (%)			0.022			0.11
<i>Inexperienced</i>	1731 (51%)	23 (72%)		3483 (33%)	28 (42%)	
<i>Experienced</i>	1632 (49%)	9 (28%)		7179 (67%)	39 (58%)	
<i>Unknown</i>	635	0		2097	0	
Completed ride, n (%)			<0.001			<0.001
<i>Yes</i>	1819(45%)	1 (3.1%)		4995 (39%)	6 (9.0%)	
<i>No</i>	2179 (55%)	31 (96.9%)		7764	61 (91%)	

Variable	Short race			Long race		
	Live, N = 3,998	Death, N = 32	p-value ¹	Live, N = 12,759 (61%)	Death, N = 67	p-value ¹
¹ Pearson's Chi-squared test; Fisher's exact test; Wilcoxon rank sum test						

Table 1. Inexperienced horses were more likely to suffer fatalities than not experienced horses in both ride types (table 2 and 3).

Table 3: Multivariate mixer logistic regression model of associations between overall fatalities (Live/Death) by ride type and predictor variables (competition and completed ride) over Raid Hipico Uruguayo (RHU) rides between competition seasons 2007-2018 in Uruguay.

Predictors	Short race			Long race		
	Odds Ratios	CI	p	Odds Ratios	CI	p
(Intercept)	0.00	0.00 – 0.00	<0.001	0.00	0.00 – 0.00	<0.001
Inexperienced [YES]	22.90	6.95 – 75.43	<0.001	37.72	18.93 – 75.16	<0.001
Completed ride [YES]	0.01	0.00 – 0.06	<0.001	0.00	0.00 – 0.00	<0.001
Random Effects						
N Ride		166			447	
Observations		3395			10729	
Marginal R2 / Conditional R2		0.076 / 0.934			0.034 / 0.969	

201 There was no association between experience and the probability of dying in LR
202 (table 2), but under a multivariate analysis (Experience and Completed ride), a
203 significant association was found between these variables in LR (table 3).

204 Horses that participated in SR completed the ride in a greater proportion than those
205 that participated in LR (Table 1). Besides, regardless of ride type, more horses died
206 during the ride than after them, so most of them did not complete the ride (Table 2 and
207 3).

208 4. Discussion

209 This is the first study to characterize RHU rides according to ride-type (short vs.
210 long), as well as the causes of death and their risk factors.

211 Equestrian endurance sports require the greatest physiological demand for the
212 athlete horse FEI 2, 4, 13, 14. The FEI endurance is the most widely described 2, 4, 15,
213 16, 17. Compared to FEI endurance races, RHU has shorter distances, higher speeds,
214 greater weight load, fewer stages, a lower proportion of horses that finish the race, and a
215 higher fatality rate. According to our data, RHU is probably one of the most demanding
216 events for horses 5.

217 During the period 2007-2018, LR were more frequent than SR, which follows the
218 same pattern as FEI endurance 14. However, unlike endurance, where the speeds of the
219 races were below 25 km/h 14, 18, 19, 20, RHU races were faster, with speed averages
220 between 28 km/h and 32 km/h, reaching maximum speeds close to 36 km/h. In
221 addition, horses completing RHU races were 10 to 40% less than those reported for
222 endurance legg naty muñoz 20, 21, 22. Another clear difference with endurance is that
223 while in RHU the main cause of elimination was due to metabolic condition (43%), in
224 endurance the highest percentage of elimination (25 to 40%) was due to lameness 14, 21,
225 22, 23 .

226 Among the main RHU characteristics the following are briefly highlighted: LR are
227 more frequent than SR; SR are faster than LR ones; SR had a higher frequency of high CI
228 than LR, and LR had a higher frequency of low CI than SR; and the percentage of
229 inexperienced horses and those who completed the ride was greater in SR than in LR.
230 Regarding fatalities, there were 99 deaths, of which 68 were euthanasia. In both types of
231 rides, more horses died during than after the ride. most causes of fatalities are
232 incompatible with endurance exercise. The horses that suffered fatalities and finished the
233 course were due to metabolic causes, with the exception of one animal that presented
234 sudden death. The higher rate of occurrence of metabolic fatalities in LR probably
235 induced the higher course completion in horses that died during LR (Table 1 and 2).

236 The probability of suffering fatalities was higher in inexperienced horses. In
237 addition, the SR were associated with increased risk of sudden death, while LR were
238 associated with increased risk of metabolic death. Therefore, this study highlights the
239 importance of characterizing RHU rides according to distance, evidencing that although
240 LR are the most frequent, the proportion of deaths is higher in SR, which also
241 determines a different profile in the causes of death and its risk factors. It is interesting
242 to note that although equine resistance sports are very popular throughout the world and
243 that popularity has been growing 24, according to our knowledge, with the exception of

244 one study 10, there are no reports on equine fatalities in endurance equestrian sports.
245 During the 12-year study period, the fatality rate in RHU was 5.87 per 1000 starts.
246

247 This result is much greater than that reported by Balch et al (2019) in endurance
248 horses under AERC rules (0.28 fatalities per 1000 starts) 10. Horse deaths in RHU
249 competitions attract the attention of public opinion and negatively affect the sensitivity
250 of the public towards these sports; also generate controversial opinions regarding the
251 intensity of the exercise carried out by the animals that participate.

252 The higher fatality rate of the RHU compared to the endurance competition, once
253 again highlights the highly demanding degree that this sport represents for the horses.
254 The metabolic requirements demanded by high speeds over long distances, with only
255 two stages, create highly challenging conditions for the RHU horse. Additionally,
256 horses run mostly on hard ground, with a high rider weight. Another characteristic of
257 the sport is the important prize money, which adds excitement to the already exciting
258 competition. and can distract competitors from the horse's state of health and well-being.
259 Since the death of equines during competitions represents a major welfare concern, it
260 should be a priority to know the frequencies and causes of death in all equine sports
261 worldwide. It is a great challenge for veterinarians to try to minimize the frequency of
262 equine deaths during sports. In this sense, the fatalities in the RHU show the need for
263 greater controls and strictness in the limits to which equines are exposed.

264 In this study it was evidenced that the type of the races (SR vs LR) in RHU was
265 influenced by the comfort index, the percentage of inexperienced horses, whether or not
266 they completed the race, the speeds, the number and causes of fatalities. The SR had
267 higher speed, higher frequency of high comfort index, greater percentage of
268 inexperienced horses and those who completed the ride in comparison with LR. In the
269 RHU, the risk of death of horses was higher in SR than in LR, unlike what was reported
270 in endurance by Balch et al (2019), in which the risk of death increased with the distance
271 traveled (0.12, 0.35 and 1.48 fatalities per 1000 stars in rides of 48, 80 and 160 km,
272 respectively). It is possible to speculate that, although less distance is covered, the big
273 locomotor and metabolic demand imposed by a greater speed in SR than in LR, has
274 determined a greater proportion of equine deaths, mainly catastrophic and sudden
275 deaths. In previous studies 24, 25 no associations were found between speed of
276 individual horses and elimination for lameness or metabolic reasons. Although in our
277 study, the speed of the races in which horses died did not differ statistically from those
278 in which they did not die, we cannot conclude that speed does not influence the deaths
279 of horses, since the speed recorded was the average speed of the stage in which they
280 died, or the average speed of the race if they managed to finish it. Therefore, the
281 individual speed of the horse was not taken into account, nor was the accumulated
282 distance, which requires another study design for its analysis.

283 The highest proportion of deaths in SR was due to sudden death, defined as acute,
284 exercise associated death in a closely observed and previously apparently healthy
285 animal 26. Cardiovascular disease is often confirmed or suspected 27. Most of the
286 studies on sudden death are in Thoroughbred racehorses and eventing horses 7, 28.
287 According to Lyle et al (2011) the prevalence of sudden death in racehorses in the UK
288 between 2000-2007 was 0.28 deaths per 1000 horses started 6. Comyn et al (2017), found

289 a prevalence of 0.14 per 1000 starts in FEI eventing horses between 2008-2014 29. In the
290 present study the mortality rate from this cause was 1.02 dead horses per 1000 starters,
291 higher than any previous report. Intense exercise requires high oxygen consumption
292 such as horse racing or 3 day events, produce large increases in cardiac output and
293 blood pressure, increasing propensity for major cardiovascular events 6, 29.

294 Navas de Solis et al (2018) studying cases of sudden death in many types of
295 equestrian sports and riding horses reported that 71.9% of the horses that suffered
296 sudden death collapsed during exercise 27. These results are in contrast to the work of
297 Lyle et al (2011) in racehorses, where most sudden deaths occurred after the race 6.
298 Exercise time during competitions in racehorses is much less than in three day eventing
299 or RHU. Probably the intensity and duration of the exercise play an important role in the
300 incidence and moment of presentation of sudden deaths in sport horses. Horses
301 collapsing during exercise may suffer catastrophic lesions and riders may fall and be
302 injured during these episodes and while riding a horse that presented sudden death.
303 Therefore, the study of the causes of sudden death during RHU, and its prevention may
304 be imperative, not only for increasing the horse's welfare, but also for human safety
305 concerns.

306 The most frequent cause of death in LR was metabolic condition. This cause of
307 death occurs mainly in horses after long duration submaximal exercises 2, 4. The marked
308 increase in metabolism for such long period of time is accompanied by intense energy
309 consumption and loss of body water and electrolyte stores, as a consequence of
310 thermoregulation 2, 4, 10, 14, 15. Mild dehydration is compatible with competitive
311 performance, however, serious medical problems may develop in horses that compete in
312 endurance events, even death 2, 15. The distance, due to the longer time in exercise,
313 probably has an influence on the presentation of metabolic alterations, since it represents
314 a risk factor for its presentation in endurance horses 14, and in our work the proportion
315 of deaths due to metabolic alterations was higher in LR.

316 The main cause of death due to metabolic disorders was Acute Abdomen
317 Syndrome (AAS). Balch (2019) reported AAS as the most common clinical presentation
318 (85%) as a prelude to death in AERC endurance races. The management of the horse
319 before and during the race can lead to episodes of AAS, such as gastric dilatation due to
320 the effect of fasting before the race and peristalsis problems due to dehydration and
321 electrolyte imbalances 2, 15.

322 Catastrophic injuries occurred in a high proportion in both ride types. In this study,
323 the animals with catastrophic injuries did not complete the ride (43/44), being
324 euthanized almost in their entirety, when the irreparable injury was diagnosed. Of the
325 total catastrophic injures, 11 were in SR and 33 in LR, although no differences were
326 found. In the present work the mortality rate due to catastrophic injuries was 2.6 dead
327 horses per 1000 starters, even higher than those reported in racehorses or in three day
328 eventing horses.

329 According to Misheff et al, (2010), the risk of suffering from bone pathologies
330 during endurance races increases with the distance covered and the increasing speeds
331 30. Most epidemiological studies show a positive association between the risk of
332 catastrophic injuries and distance covered, although not all findings have been
333 consistent 31.

334 In our study, we also show that experience is a risk factor for fatalities. Therefore,
335 another element that could have contributed to the higher risk of death in SR was the
336 greater proportion of inexperienced horses in comparison to LR.

337 Previous studies in sporting horses as endurance 25 or Thoroughbred racehorses
338 32 have found experienced horses to be associated with reduced odds of deleterious
339 outcomes compared to horses that were inexperienced (in endurance for the distance) or
340 less experienced Thoroughbred racehorses. However, the concept of inexperience is not
341 the same, since in FEI races there is a qualification system that does not allow horses to
342 compete if they have not completed shorter distance races. Therefore they are only
343 inexperienced on that distance. In our case, although many animals had competed in
344 other sports, none of the horses considered inexperienced had competed in RHU races.
345 The fatality rate for inexperienced horses was 13.2 and 8 fatalities per 1000 starts in SR
346 and LR respectively.

347 From another point of view, completing the race was also a risk factor for fatalities.
348 Not completing the race implied a higher percentage of deaths in the SR (96.6%) than in
349 the LR (91%), although the SR had a greater number of horses that completed the race.

350 Based on this set of results, it is clear that although LR are more frequent than SR in
351 RHU, the risk of death is higher in SR than in LR. Therefore, the need to control racing
352 conditions is evident, especially in SR, where speeds are higher.

353 5. Conclusions

354 In conclusion, this is the first study that characterizes the RHU races, the causes of death and
355 the risk factors.

356 SR and LR have important differences that are manifested in the characteristics of
357 the race, the causes of death and the risk of fatality. This must be considered to
358 understand the physical impact of equine participation in this type of event.

359 The high fatality index shown in this work, especially in inexperienced horses,
360 warrants urgent investigation in this sport to minimize mortality associated with RHU-
361 specific diseases and to improve the welfare of the RHU horses.

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