ANIMAL HUSBANDRY & VETERINARY SCIENCE | RESEARCH ARTICLE

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Rates and causes of elimination in Malaysian endurance horses

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Abstract: The performance of endurance horse is usually evaluated on their ability to complete the race successfully. Therefore, the purpose of the present study was to know the current completion and the elimination rate of endurance races in Malaysia. One hundred and ninety-four endurance horses were involved in the present study. All the endurance races were held in the Terengganu International Endurance Park and Az-zahra Arabian Park, Kelantan from May 2015 to August 2016. 35.05% (CI; lower limit = 28.69%, upper limit = 42%) of the horses were eliminated and 64.95% (CI; lower limit = 58%, upper limit = 71.31%) of them were able to complete the race successfully. 54.41% (CI; lower limit = 42.65%, upper limit = 65.69%), 29.41% (CI; lower limit = 19.92%, upper limit = 4.11%) and 16.18% (CI; lower limit = 9.28%, upper limit = 26.69%) of all eliminated horses was due to lameness, metabolic ailments and other reasons respectively. Most of the eliminated horses competed for 80 km while those that completed the race successfully competed in the 40 km race. This data could be of assistance to the Veterinarians in monitoring the trend of endurance races in Malaysia and improve on the current management practices to reduce the rate of elimination in subsequent races.

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PUBLIC INTEREST STATEMENT

Endurance race is a race whereby horses are allowed to cover distances ranging from 40 to 120 km and above in 24 h. During endurance race, the horses will be accessed for their ability to cover the aforementioned distances without developing a serious illness or medical problem. The tracks used for endurance races are generally flat and free of stone debris, and water points are being provided at an interval of 5 km distances along the track. Veterinary inspection is conducted after each cycle of 20–40 km within 20 min of arrival from the races and the horses were physically examined to be certain that they are free from health problems. Horses were ridden by riders with body weight ranging between 52 to 70 kg. Therefore, this study was conducted to access the physical ability of the horse to complete the race successfully. The data obtained from this study could be used to assist the veterinarians and horse owner in monitoring the trend of endurance races in Malaysia.

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Keywords: endurance horses; completion; elimination; prevalence; Malaysia

1. Introduction

Endurance races had tremendous metabolic demands as it needs to supply energy for many hours (Trigo, Castejon, Riber, & Muñoz, 2010). The elimination rate in endurance races ranges from 10–60%, depending on the course and speed (Fielding, Meier, Balch, & Kass, 2011). Endurance horse usually eliminated from the race due to three main reason, which is lameness, metabolic ailments and the other reason, such as failure to reach the veterinary gate in a certain period (overtime), or rider options to withdraw from the race due to rider's health or for the horse welfare (withdraw). Loss of performance in endurance horses can be influenced by the subclinical disease which is mainly due to respiratory problems followed by exercise-induced rhabdomyolysis, locomotor disturbance and cardiac arrhythmias (Fraipont et al., 2011).

Elimination rates in endurance races differ from one geographical area to another (Nagy, Murray, & Dyson, 2014). For instance, eliminations for metabolic disorders occur more often in hot and humid countries (Flaminio & Rush, 1998; Lawan, Noraniza, Rasedee, & Bashir, 2012). Numerous studies have established that a blend of hard tracks, abrupt vicissitudes in track surface and high speed might be linked with high elimination rates for lameness (Fraipont et al., 2011; Lawan, Ahmad Fadly, Noraniza, Abdullah, & Bashir, 2017; Nagy et al., 2014). Eliminated and successful horses have been found to vary in terms of gene expression, specifically in leukocytes, and the clinical phenotype of eliminated horses is connected with an inflammatory or catabolic gene expression profile (Barrey, Mucher, Robert, Amiot, & Gidrol, 2006). Lawan et. al. were also able to predict elimination of endurance horses based on metabolic disorder index in endurance horses before the race using hematological, biochemical and electrolyte variables such as packed cell volume, creatinine, chloride, gluthiothine reductase and interleukin-6 (Lawan et al., 2017).

Several studies have been conducted to investigate the completion and elimination rates in endurance horses. In 2008, Marlin et al. had conducted a study to determine the rates of elimination in 8 global regions from 2005 to 2007 and found that that the elimination rates for lameness increased during the period but for metabolic causes, it remains unchanged (Marlin, McEwen, & Sluyter, 2008)

In 2010, Nagy et al. had conducted another study to investigate the elimination rate from elite endurance rides in 9 countries (Australia, France, Italy, South Africa, Spain, United Arab Emirates (UAE), United Kingdom (UK), Uruguay and the United States of America (USA) and associated risk factors that may contribute to the elimination and reported only 46% of the horses were able to complete the race successfully. The authors also reported that lameness was the major causes of elimination followed by metabolic causes (Nagy, Murray, & Dyson, 2010).

Additionally, Fielding et al. (2011); also published a report regarding the elimination of endurance horses in the USA. The authors stated that elimination rate was 18.9% and the major cause of elimination was lameness (8.9%) and metabolic ailment (4.2%) (Fielding et al., 2011). They also suggested that breed, age, and ride distance were associated with increased risk of elimination. Breed with higher body mass index has a higher risk to be eliminated while Arabian crossbred horses had the lowest risk. For age, those >6 years old have higher elimination, risk compared to younger horses and longer distance has higher elimination probability compared to the short distance rides.

In Malaysia, Adamu, Adzahan, Abdullah, and Ahmad (2012); reported that 71.64% of the horses were eliminated from the races mainly due to metabolic disorders (53.73%) followed by lameness (17.91%) (Lawan et al., 2012). The authors also study the possible causes of elimination in endurance horses, which were speed, heart rate, lactate and uric acid (Adamu et al., 2012). Therefore, the data obtained from this study could be of assistance to the Veterinarians in monitoring the trend of

endurance races in Malaysia and subsequent improvement on the current management practices to reduce the rate of elimination in successive races.

2. Materials and methods

A prospective study was conducted based on the endurance events from June 2015 to August 2016 which was held in Terengganu and Kelantan, Malaysia. Out of 194, 188 were from Terengganu while 6 horses from Kelantan. From the total of 194 horses, 126 of the horses were able to complete the race while 68 of them were eliminated from the race by official veterinarian. Total races involved in this study were 12 from June 2015 to December 2016. All events were organized in the east coast of Malaysia, which nine events held in Terengganu, while three in Kelantan.

No age, breed, gender, weight and height preferences were determined in the horse selection and only apparently healthy horses free of subclinical infections were included in the study. All horses were physically examined, and physical data such as intestinal motility, capillary refill time, mucous membrane color, and skin recoil were obtained before the race and within 20 min of recovery period. The horses entered for endurance race of varying distances ranging between 40, 80 and 120 km. The races were carried out on different days in 2015 and 2016 over 12 events in Malaysia.

Veterinary inspection was conducted after each loop varying from 20 to 40 km within 20 min of arrival from the races on all competing horses and physical parameters were recorded. Selected horses were ridden by riders with body weights ranging between 52 and 70 kg. All horses were ridden by experienced and skill riders registered under FEI, riders' regulation. The race was conducted in accordance with the FEI regulations (AERC Rider's Handbook's, 2006; Fédération Équestre Internationale, 2007).

The endurance events of 40, 80, and 120 km races were conducted under tropical climate (ambient temperature and humidity for the different race distances were as follows: 40 km = 27.08 ± 0.9 °C, 70.82 ± 3.07%;80 km = 29.34 ± 1.3 °C, 70.90 ± 4.24%; and 120 km = 26.25 ± 0.22 °C, 88.62 ± 1.12%, respectively). The ambient temperature and humidity were measured using portable thermohygrometer H1936440 N, Hanna instruments Romania, and were recorded at an interval of 30 min through the race.

The tracks used for endurance races generally on the palm plantation, beaches and dirt track in several states. The topography was generally flat and free of stone debris, and water points are being provided at an interval of 5 km distances along the track where this horse is allowed to drink the water on their own. Veterinary inspection is conducted after each cycle vary from 20–40 km within 20 min of arrival from the races on all competing horses and the horse were medically examined to be certain that they are free from medical problems. Successfully completed horses are those horses that complete the race without developing any medical problem, whereas eliminated horses are those horses that develop medical problem and subsequently removed from the race as a poor performance horse.

One hundred and ninety-four horses were involved in this study. Out of 194 horses, 126 of the horses were able to complete the race while 68 of them were eliminated from the race by official Veterinarian. From the 68 eliminated horses, 37, 20 and 11 of them were eliminated due to lameness, metabolic problem and other causes respectively. Among 68 eliminated horses, eight were from Kelantan while 60 were from Terengganu.

3. Data analysis

The data obtained was analyzed using rate percent with MedCalc Statistical Sofware version 17.9.2 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org;2017). Analysis were considered significant at $p < 0.05$.

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Table 1. The participation of endurance horses in endurance races between 2015 and 2016							
Date	**Events**	**Venue**	**Total**	**SC**	**ER**	**Causes of elimination**	
June 2015	RTES Endurance Ride	TIEP	14	7	7	Lameness	2
						Metabolic	4
						Others	1
August 2015	ASEAN Endurance Ride Challenge	TIEP	18	14	4	Lameness	2
						Metabolic	1
						Others	1
November 2015	Zahra Arabian Park Endurance Ride	ZAP	6	3	3	Lameness	0
						Metabolic	2
						Others	1
November 2015	RTES Endurance Ride	TIEP	19	14	5	Lameness	2
						Metabolic	1
						Others	2
April 2016	Sultan Mizan Cup 2016	TIEP	27	8	19	Lameness	8
						Metabolic	8
						Others	3
May 2016	RTES-STC Endurance Challenge 2016	TIEP	17	12	5	Lameness	4
						Metabolic	0
						Others	1
July 2016	RTES Endurance Ride	TIEP	19	14	5	Lameness	3
						Metabolic	1
						Others	1
August 2016	Zahra Arabian Park Endurance Ride	ZAP	6	6	-	Lameness	0
						Metabolic	0
						Others	0
September 2016	RTES Endurance Ride	TIEP	17	12	5	Lameness	5
						Metabolic	0
						Others	0
October 2016	RTES Endurance Ride	TIEP	14	8	6	Lameness	3
						Metabolic	3
						Others	0
November 2016	Zahra Arabian Park Endurance Ride	ZAP	19	14	5	Lameness	5
						Metabolic	0
						Others	0
December 2016	RTES Endurance Ride	TIEP	18	14	4	Lameness	3
						Metabolic	0
						Others	1
Total			194	126	68		

Notes: SC = successfully completed; ER = eliminated from race; TIEP = Terengganu International Endurance Park; ZAP = Az-zahra Arabian Park; RTES = Royal Terengganu Endurance Stable; STC = Selangor Turf Club.

Table 1 presented the participation of endurance horses in the period 2015 to 2016 for 40, 80 and 120 km race distances. In June 2015, 14 horse participated in the event and 7 of them were able to complete the race successfully and 7 of them were eliminated. In August 2015, 18 horses participated and 14 of them were able to complete the race while 4 of them were eliminated. In November 2015, 6 horses participated in the race and 3 of them were able to complete the race while another

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Date	Total	SC	ER	Causes of elimination		Rate of elimination (%)	Confidence interval (CI)	
							Upper limit	Lower limit
2015	54	44	10	Lameness	4	7.41%	17.56%	2.92%
				Metabolic	5	9.26%	19.91%	4.02%
				Others	1	1.85%	9.77%	0.33%
2016	34	26	7	Lameness	6	17.65%	33.52%	8.35%
				Metabolic	0			
				Others	1	2.94%	14.91%	0.52%

Table 2. Rate of elimination of endurance horses from 40 km race distance in 12 races conducted in Malaysia from 2015 until 2016

Notes: SC = successfully completed; ER = eliminated from race.

3 were eliminated from the race. In another event in November 2015, 19 horses were involved and 14 of them were able to complete the race while 5 of them were eliminated from the race. In April 2016, 27 horses were participated and 8 of them were completed the race successfully while another 19 were eliminated from the race. In May 2016, 17 horses were involved and 12 of them were completed the race while 5 of them were eliminated from the race. In July 2016, 19 horses were involved and 14 were completed the race successfully while 5 of them were eliminated. In August 2016, 6 horses were participated and all the horses were completed the race successfully. In September 2016, 17 horses were participated and 12 of them were able to complete the race successfully while 5 of them were eliminated. In October 2016, 14 horses were involved and 8 of them were completed the race while 6 of them were eliminated from the race. In November 2016, 19 horses were participated and 14 of them were completed the race successfully while 5 of them were eliminated. In December 2016, 18 horses were involved and 14 were successful to complete the race while 4 of them were eliminated from the race.

4. Results
Table 2 presented the rate of elimination of endurance horses from 40 km race distance in 12 races conducted in Malaysia from 2015 until 2016. The total numbers of horses eliminated in 2015 were 10 horses. Out of 10 horses, 4 were eliminated due to lameness (7.41%, CI; lower limit = 2.92%, upper limit = 17.56%), 5 were due to metabolic problems (9.26%, CI; lower limit = 2.92%, upper limit = 19.91%) and only one horse was eliminated due to other causes (1.85%, CI; lower limit = 0.33%, upper limit = 9.77%). In 2016, the total numbers of eliminated horses were 7. Out of the seven horses, six of them were eliminated due to lameness (17.65%, CI; lower limit = 8.35%, upper limit = 33.52%) and one of them was eliminated due to other causes (2.94%, CI; lower limit = 0.52%, upper limit = 14.91%).

Table 3 presented the rate of elimination of endurance horses from 80 km race distance in 12 races conducted in Malaysia from 2015 until 2016. The total numbers of horses eliminated in 2015 were 23 horses. Out of 23 horses, 11 were eliminated due to lameness (18.65%, CI; lower limit = 10.74%, upper limit = 30.37%), 6 were eliminated due to metabolic problems (10.17%, CI; lower limit = 4.75%, upper limit = 20.46%) and 6 of them were eliminated due to other causes (10.17%, CI; lower limit = 4.75%, upper limit = 20.46%). In 2016, total numbers of eliminated horses were 26. Out of 26, 15 of them were eliminated due to lameness (44.12%, CI; lower limit = 28.89%, upper limit = 60.55%), 8 of them were eliminated due to metabolic problems (23.53%, CI; lower limit = 12.44%, upper limit = 40%) and only 3 of them were eliminated due to other causes (8.82%, CI; lower limit = 3.04%, upper limit = 22.96%).

Table 4 presented the rate of elimination of endurance horses from 120 km race distance in 12 races conducted in Malaysia from 2015 until 2016. There was limited number of horses participated in this race distance. In 2015, only 5 horses were involved and one of them was eliminated due to

Table 3. Rate of elimination of endurance horses from 80 km race distance in 12 races conducted in Malaysia from 2015 until 2016

Date	Total	SC	ER	Causes of elimination		Rate of elimination (%)	Confidence interval (CI)	
							Upper limit (%)	Lower limit (%)
2015	59	36	23	Lameness	11	18.65	30.37	10.74
				Metabolic	6	10.17	20.46	4.75
				Others	6	10.17	20.46	4.75
2016	34	19	26	Lameness	15	44.12	60.55	28.89
				Metabolic	8	23.53	40	12.44
				Others	3	8.82	22.96	3.04

Notes: SC = successfully completed; ER = eliminated from race.

Table 4. Rate of elimination of endurance horses from 120 km race distance in 12 races conducted in Malaysia from 2015 until 2016

Date	Total	SC	ER	Causes of elimination		Rate of elimination (%)	Confidence interval (CI)	
							Upper limit (%)	Lower limit (%)
2015	5	4	1	Lameness	0			
				Metabolic	1	20	62.45	3.62
				Others	0			
2016	1	0	1	Lameness	1	100	100	20.65
				Metabolic				
				Others				

Notes: SC = successfully completed; ER = eliminated from race.

metabolic problem (20%, CI; lower limit = 3.62%, upper limit = 62.45%). In 2016, only one horse was involved in this study and the horse was eliminated from the race due to lameness (100%, CI; lower limit = 20.65%, upper limit = 100%).

5. Discussion

A previous study conducted by Lawan et al. (2012) in Malaysia stated that up to 71.64% of endurance horses were eliminated from the race while only 28.36% of them were able to complete the race successfully. The current study shows that the rate of elimination of endurance horses in Malaysia had been decreased drastically with only 35.05% (CI = lower limit; 28.69%, upper limit; 42%) of horse eliminated from the race. It is a good improvement for endurance sports in Malaysia considering the welfare of the horses.

Lameness was the major causes of elimination in endurance horses in Malaysia currently. High elimination rate due to lameness can be caused by the frequent racing schedule as a horse need to recover at least 91 days interval before the next race (Nagy et al., 2014). Based on the schedule of endurance events in Malaysia, the endurance events were organized every month and the majority of the horses competing was the same horse. This can be the causes of high elimination rate due to lameness in endurance horses. Other than that, lameness also can be influenced by the speed, inexperienced rider, previous injuries of the horses, track and other unmeasured factors. Further study needs to be conducted to investigate the other causes that relate to the problems.

Distances also play an important role in endurance races. However, there was a low number of 120 km participants in the present study. So, the comparison is only done between 40 and 80 km race distances. In the present study, those who compete in a shorter distance (40 km) had the

higher probability to complete the race compared to the long distance (80 km). Other than that, the horse that had previously competed in longer distance may find that shorter distance is less tireless and the horse had higher possibility to complete the race (Nagy et al., 2014).

The present study assessed the elimination rate due to heart rate recovery and average speed (AS) variables from 2015 to 2016 of 40 and 80 km (as all were grouped under others in the tables) and found that in the 40 km race, the elimination rate increases by 62.9% while in the 80 km race it decreases by 86.7%. These findings were in consonant with the study conducted by Mohamed et al. and Adamu et al. which indicated that horses were predicted to be eliminated from the endurance race due to the heart rate recovery and average speed variables with a 70% probability of being eliminated at the subsequent gate if its cardiac recovery time is protracted for more than 11 min at vet gate 1 or 2, or extended up to 13 min at vet gates 3 or 4 (Adamu et al., 2012; Mohamed, Céline, François, & Eric, 2015).

Similarly, their result confirmed that there was an association amongst HR, CRT and AS evaluated at phase $n − 1$ and elimination at phase n (Mohamed et al., 2015). Alterations in CRT, HR and AS throughout the race are undoubtedly connected with an increased likelihood of elimination at the next vet gate (Adamu et al., 2012; Mohamed et al., 2015). The higher the speed, the higher the possibility of elimination. This result is in line with previous studies (Marlin et al., 2008; Nagy et al., 2010).

The elimination rate for metabolic disorder in the current study for 40, 80 and 120 km race increases exponentially from 2015 to 2016. This finding could be as a result of differences in the distances covered during the races and this may not be unconnected with fluctuations in the hematological, biochemical and electrolyte variables as was predicted by Lawan et al. (2017).

6. Conclusion
The study showed that the rate of elimination of endurance horses was 35.05% (CI = lower limit; 28.69%, upper limit; 42%). The major cause of elimination was lameness followed by metabolic ailments and other reason. Most of the eliminated horses competed in 80 km race distance and also there is a tremendous improvement in the rate of elimination over the previous years as divulged in the current study.

Competing interests
The authors declare no competing interest.

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References
Adamu, L., Adzahan, N. M., Abdullah, R., & Ahmad, B. (2012). Effects of speed, heart rate, lactate and uric acid on the performance of arabian horses during a 120-km endurance race. *IOSR Journal of Agriculture and Veterinary Science, 1*, 1–4. https://doi.org/10.9790/2380
AERC Rider's Handbook. (2006). *Veterinary guidelines for judging AERC endurance competitions* (p. 3–53). Auburn, CA. Retrieved January 18, 2018, from www.aerc.org

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Barrey, E., Mucher, E., Robert, C., Amiot, F., & Gidrol, X. (2006). Gene expression profiling in blood cells of endurance horses completing competition or disqualified due to metabolic disorder. *Equine Veterinary Journal, 38*, 43–49. PMID: 17402390. https://doi.org/10.1111/j.2042-3306.2006.tb05511.x

Fédération Équestre Internationale (2007). *Dressage handbook guidelines for judging*. Lausanne: Author.

Fielding, C. L., Meier, C. A., Balch, O. K., & Kass, P. H. (2011). Risk factors for the elimination of endurance horses from competition. *Journal of the American Veterinary Medical Association, 239*(4), 493–498. https://doi.org/10.2460/javma.239.4.493

Flaminio, M. J., & Rush, B. R. (1998). Fluid and electrolyte balance in endurance horses. *Veterinary Clinics of North America: Equine Practice, 14*(1), 147–158. PMID: 9561693.

Fraipont, A., Van Erck, E., Ramery, E., Richard, E., Denoix, J. M., Lekeux, P., & Art, T. (2011). Subclinical diseases underlying poor performance in endurance horses: Diagnostic methods and predictive tests. *Veterinary Record, 169*(6), 154–156. https://doi.org/10.1136/vr.d4142

Lawan, A., Ahmad Fadly, N. R, Noraniza, M. A., Abdullah, R., Bashir, A. (2017). The use of a metabolic disorder index as a predictor for metabolic eliminations in endurance horses. *Journal of Equine Veterinary Science, 51*, 113–121.

Lawan, A., Noraniza, M. A., Rasedee, A., & Bashir, A. (2012). Prevalence of lameness and metabolic disorders in endurance horses. *Malaysian Journal of Veterinary Research, 3*(1), 33–37.

Marlin, D. J., McEwen, J., & Sluyter, F. (2008). Completion and treatment rates in modern endurance racing. In *Proceedings of 4th International Equitation Science Conference* (Vol. 67). Dublin, Ireland.

Mohamed, Y., Céline, R., François, C., & Eric, B. (2015). Speed and cardiac recovery variables predict the probability of elimination in equine endurance events. *PLoS ONE, 14*(1), 1–13. doi:10.1371/journal.pone.0137013

Nagy, A., Murray, J. K., & Dyson, S. (2010). Elimination from elite endurance rides in nine countries: A preliminary study. *Equine Veterinary Journal, 42*(s38), 637–643. https://doi.org/10.1111/j.2042-3306.2010.00220.x

Nagy, A., Murray, J. K., & Dyson, S. J. (2014). Horse-, rider-, venue-and environment-related risk factors for elimination from Fédération Equestre Internationale endurance rides due to lameness and metabolic reasons. *Equine Veterinary Journal, 46*(3), 294–299. https://doi.org/10.1111/evj.12170

Trigo, P., Castejon, F., Riber, C., & Muñoz, A. (2010). Use of biochemical parameters to predict metabolic elimination in endurance rides. *Equine Veterinary Journal, 42*(s38), 142–146. https://doi.org/10.1111/j.2042-3306.2010.00238.x

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