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# EQUINE ENDURANCE RACE PACING STRATEGY AND PERFORMANCE IN 120km SINGLE-DAY RACES

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**Abstract**

Race pace strategy has been extensively studied in human sports such as running, cycling and swimming. In contrast, pacing strategy appears to have been virtually ignored in equestrian sport despite its potential to contribute to performance optimisation. Previously we have demonstrated that there are significant differences in pacing strategy between finishers and non-finishers in 120km single day endurance races [1]. The aim of the present study was to further analyse the same dataset of electronically-timed FEI 120km (single day) CEI** endurance races that took place in Europe and the Middle East in 2016 and 2017. The competition records of 218 horses that finished (average completion rate 56%) in 24 races, each consisting of 4 loops (laps) were evaluated. Final loop speed was significantly increased for horses placed in the top three who recorded 12% faster mean speed ($P=0.011$) compared to horses that finished outside of the top 3. Top 3 finishing horses also significantly increase the speed they complete loop 3 ($p= 0.040$; 3% increase in percentage of loop 1 speed) and the final loop ($p=0.008$; 8% increase in percentage of loop 1 speed) of races compared to horses who achieve lower placings and completed loop 1 at a 3% lower percentage of their average race speed ($p=0.008$) compared to those who finished 4$^{th}$ or higher. These results suggest that horses that are placed in the top 3 are ridden more consistently.

Word Count:

**Keywords:** competition; equestrian; completion; failure

## Introduction

On a global basis, equine endurance racing is the second largest Federation Equestre Internationale (FEI) discipline behind show-jumping [2]. The main distances at which high level competition takes place are 120km and 160km. Horses and riders compete at these distances in a single day. The races are broken down into 4-6 loops or laps, with mandatory veterinary inspections for fitness to continue and hold times ranging from 30-40 min between each loop.

Pacing strategy has been extensively studied in a number of sports, including marathon running, cycling and long distance swimming and a number of pacing-related factors associated with performance have been identified [e.g. 3 to 12]. The contribution of pacing strategy in equestrian sport has received virtually no attention other the study by Spence *et al.* [13] who found that better performing horses exhibited “race length-dependent pacing strategies” which were “correlated with the fastest racing times”.

We [1] recently reported that in horses racing over 120km in a single day: those horses that successfully finished recorded 7% slower average speeds; horses withdrawn at the first veterinary check for “gait” recorded a 36% faster average speed than those withdrawn at the finish; horses withdrawn for “metabolic” reasons between loops 2 and 3 reduced their speed by an average of 17% on the final loop. Overall, horses that failed to finish races appeared to be ridden with a more aggressive race strategy than those which completed. In contrast, horses that finished had a slower loop 1 pace but went on to complete subsequent loops at a higher percentage of their loop 1 speed.

The aim of the present study was to re-examine the data from the horses that completed (n=218, 56% of starters) with a view to trying to understand if pacing strategy influenced finishing position.

## Materials and Methods

Retrospective competition records for 24, 120km FEI CEI** level single-day global endurance races that took place in the 2016 and 2017 seasons were collated to compare speed related variables between horses that achieved a placing of 1$^{st}$, 2$^{nd}$ or 3$^{rd}$ in races. All races operated a fully automated electronic timing and had a results service provided by Endurance Team Styria (Hahnhofweg 30, 8075 Graz, Austria); an FEI approved timing and results service provider. Races took place in Europe (n=15) or the Middle East (n=9). For each 120km race listed in the online archive, the data were downloaded as a PDF file and converted into a Microsoft Excel spreadsheet. For each horse that started and completed the race, average speed per loop (lap, km/h) and average speed for the entirety of the race were recorded. This enabled individual horses’ racing strategy to be calculated. A strategy marker was calculated by dividing the average speed for sequential loops of the course by the average speed of the horse during loop 1, and multiplying this by 100% to give a percentage marker for each subsequent loop completed relative to loop 1. The significance of the pacing strategy deployed by horses for loop 1 was also evaluated by dividing the average speed for loop 1 by the average speed for the duration of the race, and multiplying this by 100%. This information was used to evaluate how riders used speed strategically throughout the course of a race.

A series of Mann Whitney U analyses identified if significant differences existed between loop speeds and average speed, and the strategy deployed within horses that placed in the top three compared to horses that completed outside of the top three ranks. Subsequent Kruskal-Wallis tests investigated if differences in speed and the strategic approach applied in the race occurred between horses placed first, second and third in FEI CC** single-day 120km races. Significance was set at $P<0.05$.

## Results

Competition records for 218 horses (56%) that successfully completed the 24 races surveyed were evaluated; the remaining 44% (n=171) were eliminated. Thirty-three percent (n=72) of horses finished races with a top three placing ($1^{st,}$ $2^{nd}$ or $3^{rd}$), with the remaining 67% (n=146) successfully completing the races outside of these ranks (range: $4^{th}$ to $21^{st}$ place).

### Race speed

Loop speed decreased sequentially throughout races from loop 1> loop 2> loop 3 but then increased for the final loop (Figure 1). Horses that went on to achieve a top three ranking completed all loops at a higher average speed than those that finished in the lower rankings, recording a 5% faster average speed across the entire race (Table 1). Despite this, no significant differences in speed were found for loops 1, 2 or 3 ($P>0.05$), although final loop speed was significantly increased for horses placed in the top three who recorded 12% faster mean speed ($P=0.011$) compared to the other finishers. Variation in speed on each loop (%CV, Table 1) was always lower in top 3 placed horses, with the exception of loop 3. In both groups the greatest variation in speed was on the final loop (Top 3 31%; Other placings 41%).

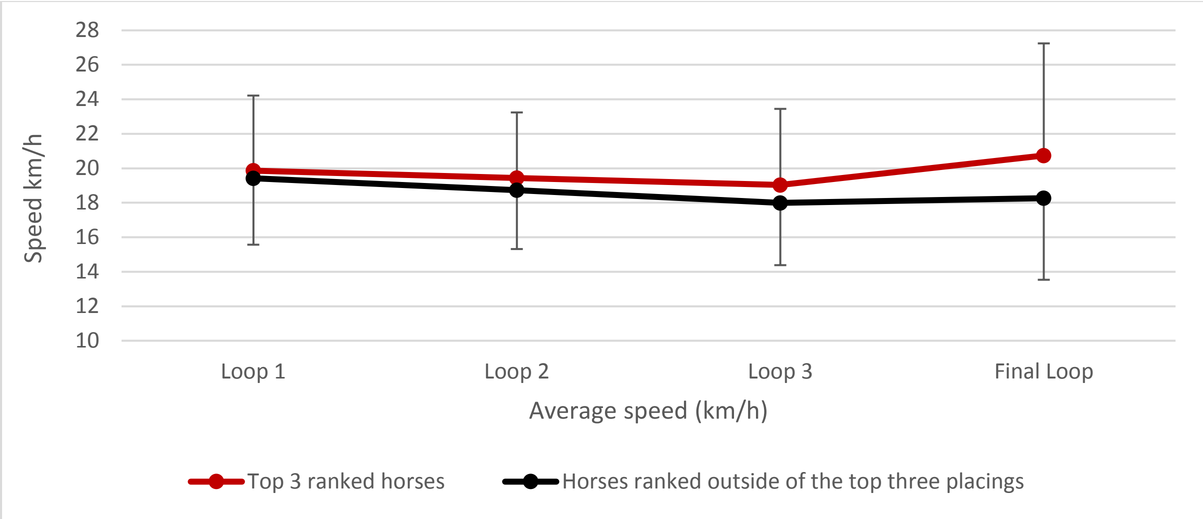


Figure 1: Differences in speed profiles (mean±sd) between endurance horses which successfully completed races with a top three finish and horses which completed outside of the top three places; km/h: kilometres per hour; sd: standard deviation.

Table 1: Race speed profiles for horses that placed in the top three positions and those that completed but outside of the top three placings to 2 decimal places; km/h: kilometres per hour; sd: standard deviation; IQR: interquartile range; %CV: coefficient of variation.

| | | Loop1 km/h (%CV) | Loop 2 km/h (%CV) | Loop 3 km/h (%CV) | Final Loop km/h (%CV) | Average whole course km/h (%CV) |
|---|---|---|---|---|---|---|
| Horses with a top 3 placing | mean±sd | 19.9±4.4 (22%) | 19.4±3.8 (20%) | 19.0±4.4 (23%) | 20.7±6.5 (31%) | 19.5±4.4 (23%) |
| | median±IQR | 18.7±7.4 | 18.8±5.7 | 17.9±7.2 | 20.2±11.0 | 18.0±7.6 |
| Horses placed outside the top 3 | mean±sd | 19.4±3.9 (35%) | 18.7±3.4 (30%) | 18.0±3.6 (20%) | 18.3±4.7 (41%) | 18.5±3.5 (35%) |
| | median±IQR | 19.3±6.7 | 18.6±5.5 | 17.7±5.1 | 17.7±7.3 | 18.1±6.3 |

<u>Race strategy</u>

Horses that successfully finished 120km CEI ** races appeared to adopt a similar pacing strategy, however those that go on to attain a top three finishing position maintain a faster average racing speed (as a % of their Loop 1 speed) throughout the duration of the race (Figure 2; Table 2). These better performing horses also complete loop 3 faster (p= 0.040; 3% increase in percentage of loop 1 speed) and the final loop faster (p=0.008; 8% increase in percentage of loop 1 speed) compared with horses who achieve lower placings. Additional differences in pacing strategies were also apparent in the earlier stages of races. Top 3 finishing horses reduced the speed they completed loops 2 and 3 (1.4% and 3% reduction in percentage of loop 1 speed, respectively) approximately 50% less on the first loop and 25% less on loops 2 and 3, than their less successful competitors (3% and 4% reduction in percentage of loop 1 speed, respectively). On the final loop, 57% of top 3 placed horses completed faster than their loop 1 speed compared with 47% of lower placed horses. In comparison, on the final loop only 9% of top 3 placed horses completed at <75% of their loop 1 speed compared with 18% of lower placed horses. The greatest variation in speed as a % of loop 1 speed was seen in both groups on the final loop.

The significance of the pacing strategy deployed for loop 1 was also investigated; horses which achieved a top 3 rank completed loop 1 at a 3% lower percentage of their average race speed (p=0.008) compared to those who finished 4$^{th}$ or higher, suggesting consistency is a more successful strategy to enhance performance in CEI** endurance races.

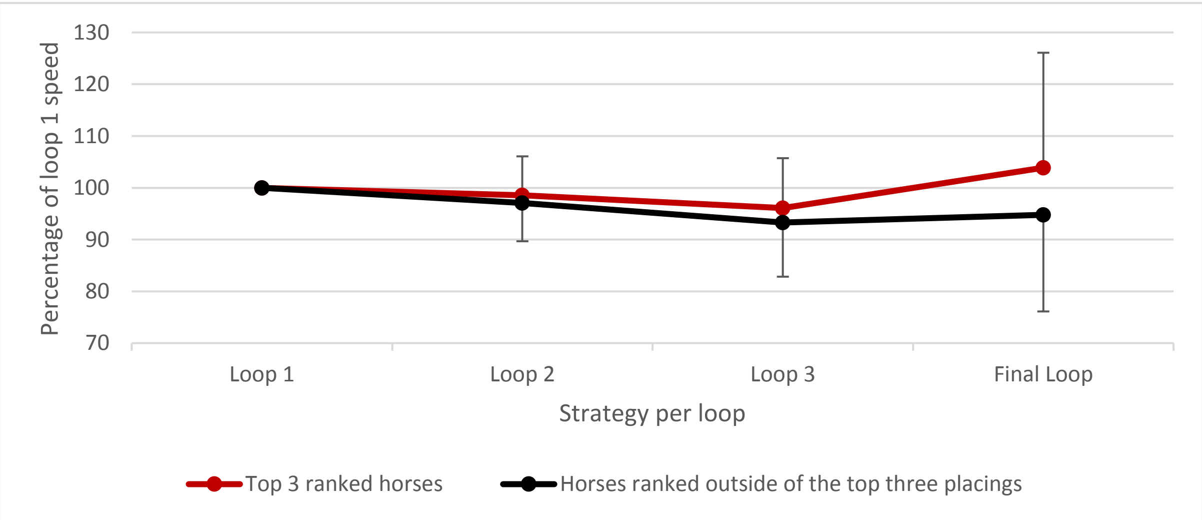


Figure 2: Differences in strategic profiles between endurance horses which finished in the top 3 and horses finished outside the top 3; %: percentage of loop 1 mean speed selected loop completed at; L1: Loop 1; L2; Loop 2; L3: Loop 3: Finish: final loop.

Table 2: Race strategy profiles (mean±sd) for horses that finished in the top three compared to those completing outside of the top three places; %: percentage of loop 1 speed selected loop completed at.

| | | Loop1 % | Loop 2 % | Loop 3 % | Final Loop % | Average whole course % |
|---|---|---|---|---|---|---|
| Horses with a top 3 placing | mean±sd | 100±0.0 | 98.6±7.5 | 96.1±9.6 | 103.9±22.2 | 102.2±8.0 |
| | median±IQR | 100±0.0 | 98.3±9.5 | 98.4±10.4 | 104.9±26.9 | 100.2±8.4 |
| Horses placed outside the top 3 | mean±sd | 100±0.0 | 97.1±7.4 | 93.3±10.5 | 94.8±18.7 | 105.0±8.5 |
| | median±IQR | 100±0.0 | 97.2±9.0 | 95.3±11.9 | 98.5±23.7 | 102.9±8.3 |

**Discussion and conclusions**

Within endurance races, riders must continuously adapt and maintain the horse's gait and speed to optimise performance [14]; in effect applying a pacing strategy.  We have previously reported that competitors in FEI CEI** 120km single day races who applied consistent pacing strategies delivering sustainable speeds were less likely to be eliminated [1]. Analysis of race finishers further suggests that pacing strategy influences competitive success. Similar patterns in race completion were observed for both groups of finishers investigated, with a sequential decrease in speed from loop 1 through to loop 3, followed by an increase in speed for the final loop. The average speed of the horses who recorded a top three rank in races was consistently higher than the other combinations who completed the races. Differences in race pacing strategy also occurred between the groups; top three horses completed loops 1 to 3 at a more consistent pace (5% variation from loop 1 speed) compared to horses placed fourth and above (7% variation from loop 1 speed). Interestingly, although both groups increased their speed during the final loop, the top three ranked horses recorded speeds which were higher than what they had used for loop 1(>100%) whilst the lower ranked horses did not attain their loop 1 speed (95%). The pacing strategy adopted for loop 3 and the final loop appear to be significant in predicting which horses are more likely to achieve success, with superior performers able to complete these at a higher percentage of loop 1 speed than their peers.

Our results suggest that combinations who adopt a higher average speed throughout races but manage this through a more consistent pacing strategy are more likely to achieve a top 3 rank in FEI CEI** 120km single day races. The association between performance and higher average race speed identified here reinforces the importance of appropriate preparation and training to ensure endurance horses possess suitable fitness levels to meet the demands of competition. The use of appropriate pacing strategies during racing is also key to maintain optimal performance during racing. Consistent pacing strategies for loops of the track are associated with superior performance in human athletes competing in endurance running [7 -9]. Our results suggest adopting a similar approach could optimise the performance of combinations in endurance racing. Endurance trainers and riders should also consider how the training regimens implemented are preparing horses for races. Regular monitoring of fitness parameters, such as heart rate, evaluation of speed and pacing work are recommended to ensure horses are suitably prepared for races and to support the application of pacing strategies during competition [1]. Furthermore, it appears that for many horses that fail to complete, this may be due to riding too fast on the first loop for the horses ability and level of fitness. Use of heart rate monitors in training to establish the heart rate and velocity relationship or use in races could reduce eliminations and help identify optimal race strategy. Further studies investigating how pacing strategies are used across different levels of competition and to identify optimal pacing strategies to enhance performance in endurance racing are warranted.

Conflicts of interest: none

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