Factors for determining stride frequency in Thoroughbred horses during racing

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Summary

The present study investigated horse- and race-level factors affecting stride frequency in Thoroughbred racehorses during races with Global Navigation Satellite System (GNSS) sensors. Stride frequency was calculated from GNSS speed spectrograms at 3 racing phases (phase 1; 200 m after gate open, phase 2; 10 m after reaching the final straight stretch, phase 3; 130 m before the finishing line) during races on turf and dirt tracks. Increased speed, decreased body weight, male sex, and shorter race distance were associated with higher stride frequency. Further, there was a significant interaction between surface type and racing phase. Our results suggest that Thoroughbred horses change stride frequency during races according to racing phase and surface.

Introduction

Monitoring stride parameters via wearable sensors may be useful for maximizing racehorse performance and preventing musculoskeletal injury [1]. Although only one study demonstrated that male sex, better racing results, firm track condition, and longer race distance were associated with lower stride frequency in Australia [2], more information including surface type is warranted because surface properties affect stride parameters in humans [3] and horses [4]. We aimed to elucidate the race- and horse-level factors affecting stride parameters during Thoroughbred races in Japan.

Methods

Global Navigation Satellite System (GNSS) sensors (Fujitsu high resolution sensor, Fujitsu, Tokyo, Japan) sampling at 10 Hz were attached to 921 horses (1,189 starts) participating in 83 races, with distances ranging from 1000 to 1800 m, held from April to July in 2024 at 5 racecourses. Based on published protocols [5], stride frequency was calculated from GNSS speed spectrograms at three racing phases (phase 1; 200 m after gate open, phase 2; 10 m after reaching the final straight stretch, phase 3; 130 m before the finishing line), where horses are considered to exert their maximal efforts. Additionally, ten variables (race distance, surface type, sex, age, racing results, racing class, racecourse, surface condition, body weight and speed) were analyzed. A multivariable linear mixed model with stride frequency as the outcome variable was fitted to the data, with individual horse and each race meeting as random effects. For selection of explanatory variables including two-way interactions between variables, we used a backward stepwise variable selection procedure until only those with $P < 0.05$ remained.

Results and Discussion

Mean (± standard deviations) stride frequency, stride length, and speed were 2.36 ± 0.12 Hz, 7.30 ± 0.39 m, and 17.2 ± 1.15 m/s across all phases and starts. The final model included 4 main effects (speed, sex, race distance, bodyweight) and a two-way interaction between surface type and racing phase. Conditional R^2 of this final model was 0.78, while the marginal R^2 (i.e., only fixed effects considered) value was 0.55. This suggests individual variability may play an important role in determining stride frequency. In reference to the interaction between surface type and racing phase, stride frequency was higher on dirt during the last part of the race (phase 2 and 3) but not the beginning (phase 1; Table 1). Further, increased speed (per 1 m/s), male sex, short race distance, and decreased body weight (per 50 kg) were associated with higher stride frequency.

Conclusions

Our results suggest that Thoroughbred horses change stride parameters during races according to racing phase and surface with moderate inter-horse variability. These factors should be considered when using stride parameters to evaluate performance and predict injury.

References

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Table 1: Coefficients of interaction between racing phase and surface in the multivariable mixed model.

Category	Coefficients	95% Confidential Intervals	P - value
Phase 1 x Dirt	Reference		
Phase 2 x Dirt	0.064	0.054 – 0.074	< 0.001
Phase 3 x Dirt	0.038	0.027 – 0.050	< 0.001
Phase 1 x Turf	-0.001	-0.015 – 0.011	0.84
Phase 2 x Turf	0.029	0.016 – 0.042	< 0.001
Phase 3 x Turf	0.008	-0.006 – 0.021	0.28