

Clayton H.M. *Sport Horse Science, 3145 Sandhill Road, Mason, MI 48854, USA*

Hobbs S.J. *University of Central Lancashire, Centre for Applied Sport and Exercise Sciences, Preston, UK*

Email: [claytonh@cvm.msu.edu](mailto:claytonh@cvm.msu.edu)

**Reasons for performing study:** Published data describing ground reaction forces (GRF) of passage are limited to vertical forces and impulses during treadmill locomotion.

**Objectives:** To compare sagittal plane GRFs of collected trot and passage during overground locomotion.

**Study design:** Repeated measures.

**Methods:** Vertical and longitudinal GRFs were recorded in 8 elite dressage horses (4 Warmbloods, 4 Lusitanos) ridden over force plates to record GRFs for three forelimb and hindlimb stance phases per horse at collected trot and passage. Peak values, their times of occurrence and respective impulses were determined for vertical, longitudinal braking and longitudinal propulsive GRF components. Differences between breeds were evaluated using independent samples *t*-tests and between gaits and limbs using repeated measures ANOVA ( $P < 0.05$ ).

**Results:** Mass-normalised forelimb and hindlimb vertical impulses for collected trot were significantly higher in Warmbloods than Lusitanos. Longer stance durations resulted in higher vertical impulses in passage (forelimbs:  $2.85 \pm 0.08$  Ns/kg; hindlimbs:  $2.43 \pm 0.13$  Ns/kg) compared to collected trot (forelimbs:  $2.44 \pm 0.20$  Ns/kg; hindlimbs:  $1.81 \pm 0.14$  Ns/kg) even though peak vertical forces were similar. In the longitudinal direction there was greater variability in passage. Compared with collected trot, passage showed significantly smaller peak braking force in the hindlimbs (collected trot:  $-0.51 \pm 0.16$  N/kg; passage:  $-0.24 \pm 0.23$  N/kg) and peak propulsive force in the forelimbs (collected trot:  $0.77 \pm 0.28$  N/kg; passage:  $0.48 \pm 0.32$  N/kg).

**Conclusions:** Vertical forces and impulses recorded overground were similar to those on the treadmill<sup>1</sup> with the exception of forelimb peak vertical force in passage, which was ~10% lower and considerably more variable in this study. In passage the demand for large vertical excursions of the centre of mass while moving with low forward momentum is achieved with markedly convergent GRF vectors, and the inherent challenges to the horse's balance are reflected by high inter-horse and inter-stride variability in longitudinal GRFs.

**Ethical animal research:** Study performed with approval from the institutional animal care and use committee, Michigan State University, USA under protocol number 02/08-020-00. Owner consent was not stated. **Sources of funding:** McPhail endowment at Michigan State University. **Competing interests:** None declared.