The impact of landing gradient on cross-country jump biomechanics.

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INTRODUCTION:

The event horse must execute the cross-country phase of the CCI4* competition, characterised by solid fences and varying terrain. Understanding how **gradients alter kinematic variables** can be advantageous to the equine sector as it provides insight into the mechanical requirements for the elite horse when jumping out on course; current research of modern eventing is limited. The current study investigated the **differences** in **forelimb kinematics**, **trunk angle** and **time** from the start of carpal extension on landing to trailing limb contact within a group of **elite horses** executing two different palisade-style fences.

METHOD:

Two-dimensional kinematic data were collated from 12 competitors during the cross-country phase of **NAF Five Star Hartpury International Horse Trials (CCI4*)** over two fences: one on the **flat** (fence 19) and one on a **downhill** gradient (fence 8a).

Recordings were taken via video cameras set perpendicularly to the left (on approach) of the two fences. After digitisation using Kinovea (version 0.9.5), angles of the **scapulohumeral**, **humeroradial** and **radiocarpal joints**, and **trunk angle** were determined at three phases of the jump effort: the **start of carpal extension** during landing prior to forelimb impact, **maximum forelimb extension** prior to forelimb impact and **impact** of the **trailing forelimb** at landing.

Time recordings of the total duration of the 3 analysed jump phases were taken.

Data were assessed for normality (Shapiro-Wilks) and, depending on normality, a Paired t-test or Wilcoxon test was employed to test for differences, using SPSS software (IBM SPSS Statistics, version 29).

Figure 1 (right): Front & side views, with dimensions, of A) the fence on the flat gradient & B) the fence on the downhill gradient.

Figure 2: Joint angles measured: Fence 8a: A) start of extension B) maximum extension C) landing; Fence 19: D) start of extension E) maximum extension F) landing

RESULTS:

The **scapulohumeral joint angle** was significantly **more flexed** ($P \leq 0.05 – P \leq 0.01$) at the start of carpal extension during landing ($\Delta 7.7°$) and at maximum forelimb extension before trailing limb impact ($\Delta 6.85°$) when jumping on the downhill gradient compared to the flat.

The **trunk angle less steep** ($P \leq 0.05 – P \leq 0.001$) over the fence on the downhill compared to on the flat ($\Delta 14.85°$, $\Delta 8.95°$, $\Delta 5.55°$), reflecting the **increased total time duration** ($P \leq 0.001$) from the start of carpal extension during landing to the impact of the trailing forelimb on landing.

The angles of the distal limb did not significantly alter with changes in landing gradient.

DISCUSSION & CONCLUSIONS:

The **increased flexion** in the **scapulohumeral** joint recorded for the downhill landing is likely to be **influenced** by **decreased stride frequency** and **decreased longitudinal propulsive forces** (Chateau *et al.,* 2014) undertaken during the approach to the fence.

Variation in the **time** to landing is related to the **trajectory** over each fence. The **flatter landing** encouraged a more **elevated trajectory**, characterised by a more **upright trunk angle**, thereby increasing the **time** in the **suspension phase**.

The findings provide an **original insight** into the **mechanical impacts** on the elite event horse jumping on **different gradients**. Thus, allowing course designers to set locations and distances between fences (Clayton *et al.*, 2021; Clayton and Barlow, 1989).

References:

Chateau, H., Camus, M., et al. (2014) Kinetics of the Forelimb in Horses Trotting an Uphill and Downhill Slope, *Equine Veterinary Journal*, 46(S46), pp. 37–37.

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