

The Impact of Load Size and Shape on Functional Performance in Working Dog Breeds

James P Charles¹, Eithne J. Comerford^{1,2}, Victoria F Ratcliffe³, Suzanne Cottrell⁴, Karl T Bates¹

¹Department of Musculoskeletal & Ageing Science, Institute of Life Course and Medical Sciences, University of Liverpool, Liverpool, UK

²Department of Small Animal Clinical Sciences, Small Animal Teaching Hospital, University of Liverpool, Neston, UK

³Defence Science and Technology Laboratory, Salisbury, Wiltshire, UK

⁴Department of Equine Clinical Science, University of Liverpool, Neston, UK

Email: J.charles@liverpool.ac.uk

Summary

Wearable technologies are becoming more prevalent in the daily tasks of working dogs. However, the impact of the size and shape of these loads on task performance in various breeds of working dog is unknown. Variable between-breed responses to load size and shape are found during trotting, weaving and hurdling tasks in a cohort of Labradors, Spaniels and Shepherds. This suggests certain breeds may be better suited for some working tasks compared to others, which may be related to variations in gross body morphology.

Introduction

There is a growing need for working dogs to carry additional equipment to facilitate or enhance the completion of their tasks, and carrying these wearable devices often involves bearing substantial loads on or around their spines. However, the biomechanical effects of the shape and/or mass of these devices on working dog performance are unclear. Previous research into this area is limited, with many studies using only a small sample size of dogs from a mixture of breeds to investigate the impact of load-carrying during a small range of behaviours [1,2]. This work aimed to build on these past studies by examining the comparative impact of carrying various types and magnitude of load on functional performance in a range of typical working breeds.

Methods

A total of 27 dogs were recruited, including 10 Labradors (Age - 3.7 ± 2.5 years, Body mass- 25.8 ± 0.31 kg), 10 Springer/Cocker Spaniels (Age- 4.6 ± 1.85 years, Body mass- 14.9 ± 0.23 kg) and 7 Shepherds (Age- 3.6 ± 1.71 years, Body mass- 33.7 ± 0.33 kg). All owners signed informed consent prior to taking part in the study, which was granted ethical approval by the University of Liverpool Veterinary Research Ethics Committee (VREC; VREC1200). 3D motions during trotting locomotion, weaving and hurdling were recorded for each dog using motion capture, with 38 reflective markers placed at key anatomical landmarks. Each task was performed by each dog in at least three load-carrying conditions: No weight, bags (10% body mass; Bags^{10%BM}) and cylindrical tube (5% body mass; Tube^{5%BM}), with an additional tube (10% body mass; Tube^{10%BM}) condition carried out by the Spaniels only. Outputs were generated from each task from each dog using scaled biomechanical models in OpenSim [3].

Results and Discussion

The impact of load type and weight were both breed and task-dependent. Heavier loads impacted functional performance more than lighter loads during trotting, with more significant between-load differences seen in Bags^{10%BM} compared to Tube^{5%BM}. However, these differences were only seen in the Labradors, with minimal differences in the Shepherds and Spaniels. Conversely, weaving and hurdling performance appeared to be more impacted by load shape rather than size, with larger differences to the 'no weight' condition seen with the Tube^{5%BM} than the Bags^{10%BM}. However, while the between-load differences in hurdling performance were larger in Labradors than in Shepherds and Spaniels, the opposite was seen in weaving, with larger differences in performance seen in Shepherds and Spaniels. Across the entire study cohort, the differences in trotting performance between the no weight and Tube^{5%BM} conditions were significantly related to variations in body shape, while hurdling performance in response to load carrying was related to body size. Weaving performance in both load-carrying conditions was related to factors beyond body size and shape.

Conclusions

This load size and shape dependence on performance impact raises important considerations for breed suitability for certain tasks, some of which are directly related to inter-breed variations in body shape. This suggests that despite the broad geometric similarity of these breeds, slight variations in their body proportions may confer advantages in optimising performance in certain working tasks.

Acknowledgments

Funding for this study was provided by the UK Ministry of Defence (MOD). The authors also acknowledge funding from the Royal Society (Apex Award- AA21\100124) and the BBSRC (BB/X014819/1). The authors would also like to thank the owners of all the dogs who took part in the study, including the Merseyside Police Dogs Section.

References

- [1] Lee, D. V. (2011). *J Exp Biol*, **214**, 402-411.
- [2] Kilbourne, B. M. & Carrier, D. R (2016) *J Exp Zool A Ecol Genet Physiol*, **325**, 655-674.
- [3] Seth, A. (2018). *PLoS Comput Biol*, **14**

