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# Risk factors for equine laminitis: A case-control study conducted in veterinary-registered horses and ponies in Great Britain between 2009 and 2011

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ABSTRACT

Laminitis is a highly debilitating disease of the foot known to have a complex and multifactorial aetiology of metabolic, inflammatory, traumatic or vascular origin. The disease has major welfare implications due to unrelenting pain associated with degenerative changes, which often necessitate euthanasia on welfare grounds. Despite this, there have been few high-quality studies investigating risk factors for equine laminitis, and only a limited number of risk factors have been previously investigated. The aim of this study was to conduct a case-control study of risk factors for active episodes of veterinary-diagnosed laminitis in horses and ponies attended by veterinary practitioners in Great Britain, based on multivariable statistical analyses.

Questionnaires were received for 1010 animals, comprising 191 laminitis cases and 819 controls. Factors associated with an increased risk of laminitis were weight gain in the previous 3 months, summer and winter months compared to spring, new access to grass in the previous 4 weeks, box rest in the previous week, owner-reported history of laminitis, lameness or foot-soreness after shoeing/trimming, existing endocrinopathic (pituitary pars intermedia dysfunction and equine metabolic syndrome) disease and increasing time since the last anthelmintic treatment. Factors associated with a decreased risk of laminitis were increasing height (cm), feeding of additional supplements in the previous week and transportation in the previous week. Novel associated factors were identified that may aid in the management and prevention of the disease in the veterinary-registered equine population.



## Introduction

Laminitis is a highly debilitating disease of the foot that is known to have a complex and multifactorial aetiology of metabolic, inflammatory, traumatic or vascular origin (Hood, 1999a; Johnson et al., 2004b; Pollitt and Visser, 2010). Pathological changes induced within the suspensory apparatus of the distal phalanx (SADP) (Hood, 1999b; Budras et al., 2009), result in foot pain that changes stance and gait characteristics (Pollitt, 2010). If SADP degradation is minimal the animal can recover (acute phase laminitic) or, if extensive and SADP failure occurs, will progress to permanent anatomical foot changes and altered patterns of hoof horn production (chronic phase laminitic) (Collins et al., 2010b).

Research into laminitis has been confounded by conflicting theories on the pathogenesis and an incomplete understanding of the mechanisms resulting in SADP failure (Eades, 2010). Proposed aetiologies include systemic disturbances that induce a systemic inflammatory response syndrome (SIRS), similar to human organ failure (Hood, 1999a; Belknap et al., 2009). Vascular problems have also been proposed (Hood et al., 1993) and the application of excessive forces/direct trauma to the digit, including prolonged weight bearing following unilateral lameness ('support limb laminitis') (van Eps et al., 2010). Laminitis occurring in association with pasture, obesity, equine metabolic syndrome (EMS), pituitary pars intermedia dysfunction (PPID) and glucocorticoid administration has been termed 'endocrinopathic laminitis' (Johnson et al., 2004a).

Multiple risk factors have been postulated to influence the development of laminitis, however few high-quality studies have been conducted (Wylie et al., 2011). Previous publications focussed on easily measurable factors and no previous studies have investigated diverse management features. Moreover, only a limited number of studies have been conducted in the general horse

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population (Wylie et al., 2011). Better understanding of the risk factors associated with laminitis would allow the implementation of preventive measures to decrease the frequency of the disease.

The aim of this study was to investigate risk factors for clinically apparent equine laminitis in animals attended by veterinary practitioners in Great Britain (GB), using appropriate multivariable techniques. The study is presented considering recommendations of the *Strengthening the Reporting of Observational studies in Epidemiology* (STROBE) statement (von Elm et al., 2007).

## Materials and methods

### *Study design, sample size and study population*

A prospective multicentre case-control study was conducted, nested within a cohort of equine veterinary practices contributing to a longitudinal study of equine laminitis in GB between May 2009 and April 2011.

Sample size estimations (EpiInfo version 3.5.3) indicated that approximately 150 cases and 600 controls were required, based on assumptions of a minimum effect size of 2.0, a minimum exposure rate among controls of 10%, 95% confidence level, 80% power and four controls per case. The study population and sampling frame are illustrated in Fig. 1.

### *Data collection for laminitis cases*

Cases were horses/ponies with 'active' episodes of laminitis defined as an occurrence of veterinary-diagnosed, clinically apparent laminitis attended by participating veterinary practices (Fig. 2). The study aimed to identify all cases experiencing laminitic pain necessitating veterinary care, including (1) acute phase laminitis, (2) chronically laminitic equines experiencing a recurrent episode of acute phase laminitis, and (3) chronically laminitic equines experiencing pain from recrudescent degenerative changes. To be eligible as a case, veterinarians had to complete a 'laminitis reporting form' (LRF) when diagnosing laminitis, detailing their observations on typical laminitis clinical signs, as illustrated in Fig. 3.

To collect owner-reported risk factor information, an 'equine laminitis questionnaire' (see Appendix A. Supplementary material) was developed following a literature review, and included sections on signalment, laminitis history, turnout, stabling, feeding, transport, exercise, farriery and health. Information was gathered on variables considered to be biologically linked with laminitis or potential confounders. Information was sought regarding the preceding 7 days, unless otherwise stated. Practitioners were asked to indicate whether an owner was willing to receive a questionnaire. Reminder cards were sent out to enhance response rates to case questionnaires mailed directly from the Animal Health Trust (AHT).

### *Data collection for controls*

A control was defined as any horse/pony from the study population that was not an active case (Fig. 4). The control 'equine management questionnaire' gathered owner-reported data as for cases. The questionnaire design facilitated identification of any controls that met case inclusion criteria. An animal could serve as a control on more than one occasion and could act as a control prior to, or after, becoming a case, but was excluded if it developed laminitis in the week pertaining to data collection.

Controls were selected by random sampling of the horses/ponies under the care of the participating practices. Information was sought for a set number of controls per month from recruited practices, weighted by the reported practice population size and sent with monthly invoices or newsletters. No incentives were offered for participation. Both questionnaires were pilot-tested.

### *Data capture and verification*

Both questionnaires were developed on TeleForm (Cardiff Software Publishing) data capture software, which was used to scan and verify the data prior to export to an analysis package.

### *Statistical analyses*

Initial examination, data coding and descriptive analyses were conducted using Excel (Microsoft). All further analyses were conducted using Intercooled Stata 9.2 (StataCorp). Univariable analysis of all variables was conducted to evaluate the strength and direction of any association with laminitis. Statistical

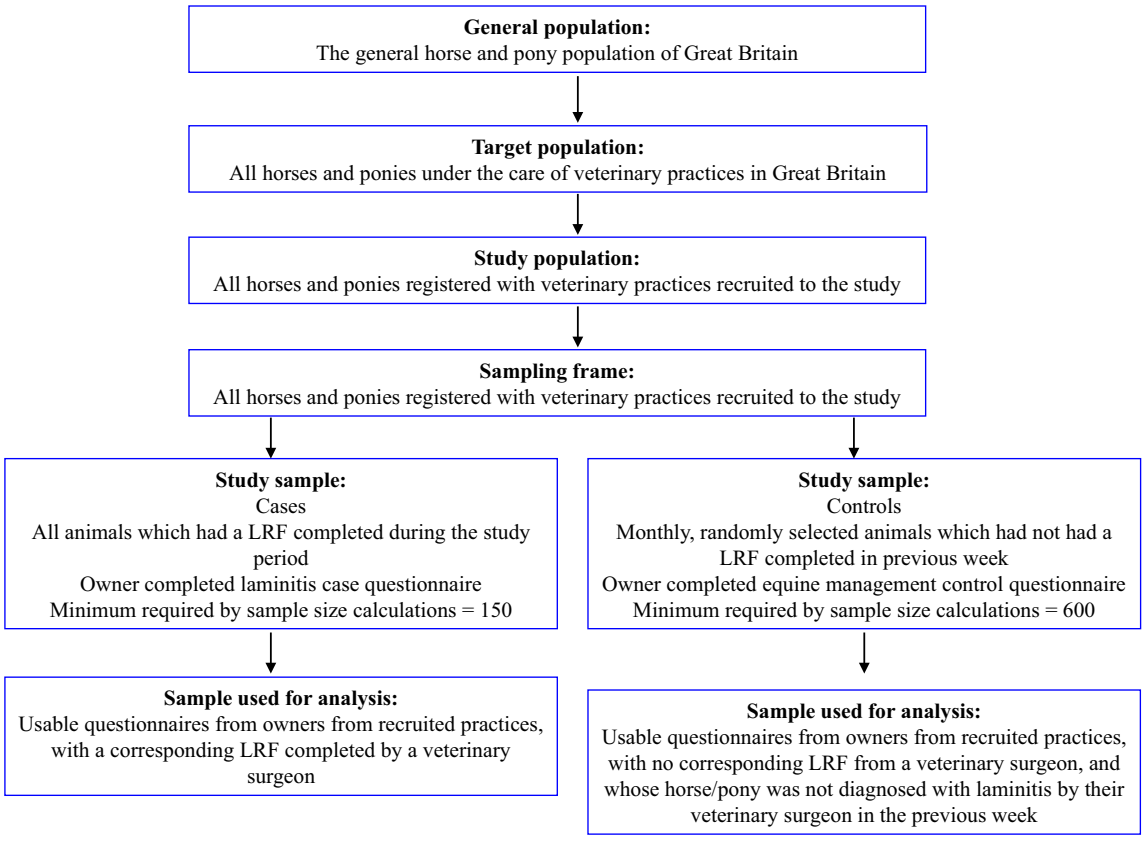


**Fig. 1.** Flow diagram of the study population and sampling frame used for the nested case-control study.