

Commercial equine production in New Zealand 4: welfare implications of the New Zealand production systems

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ABSTRACT

From racehorses to family pets, equine production and management is primarily pasture-based in New Zealand. Pasture-based equine production systems largely reflect the horse's ecological niche and have a unique set of management and welfare challenges. This review examines the potential welfare issues related to the management of horses in New Zealand. The economic value of horses varies greatly depending on their usage, which covers a wide spectrum from pest species (e.g. feral horses) to production (e.g. racehorses) and companion animals (e.g. leisure and sport horses). The view of where the horse is positioned on this spectrum may cause differing welfare threats to horses, due to the economic considerations, which drive the majority of welfare and management decisions. The organisation, management, racing and wastage metrics of the Thoroughbred racehorse industry are well documented, and the benefits of the pasture-based system have become evident through less stressful weaning practices and opportunity for early exercise (which has been associated with longer careers and fewer musculoskeletal injuries). Identification of equine-welfare research priorities in New Zealand remains challenging, given the lack of vertical integration of many sectors of the equine industry resulting in fragmented and limited availability of data.

Keywords: agricultural systems, animal behavior, animal husbandry, animal welfare, bone strength, farming systems, horses, nutrition, pasture, reproduction, surveys.

Introduction

The welfare of animals, including horses, has been deemed important to society in New Zealand (Ministry of Agriculture and Forestry 2011). All horses in New Zealand are covered by the Animal Welfare Act 1999 (New Zealand Government 2022), and both the minimum and best-practice standards for care and management of horses living in a domestic environment are outlined in the Codes of Welfare for Horses and Donkeys (New Zealand Government 2018). The National Animal Welfare Advisory Committee acknowledged the explicit recognition of animal sentience within the Animal Welfare Act in 2015. Additionally, many of the official governing bodies in New Zealand, such as Equestrian Sports New Zealand, New Zealand Pony Club Association (NZPCA) and New Zealand Thoroughbred Racing, emphasise the importance of welfare and have their own codes of conduct for the care and management of the horses within their respective disciplines (NZPCA 2015; Mellor and Burns 2020; New Zealand Thoroughbred Racing 2021).

The racing industry (Thoroughbred and Standardbred) forms a large and highly regulated part of the equestrian culture in New Zealand (Bolwell et al. 2020). Due to the highly public nature of the industry, it has been increasingly under public scrutiny in terms of its social licence to operate (public acceptance of racing as a sport and commercial activity), with the welfare of the horse both during and after their racing careers becoming increasingly important to many sectors of society (Legg et al. 2019; Heleski et al. 2020).

Equine production systems in New Zealand are primarily pasture-based due to the temperate climate. Year round, even high-level competition horses spend a large proportion of time at pasture, which is in stark contrast to the intensive management of horses

in Europe (Verhaar *et al.* 2014). The ability to have continuous free access to pasture, and thus exhibit locomotor and foraging behaviour resembling that of the horse's evolutionary ecological niche, may be linked to perceived lower rates of colic in New Zealand horses (Cohen *et al.* 1999; Scantlebury *et al.* 2015). Pasture-based management systems could also be seen as superior to more intensive systems, as horses managed on pasture are reported to display fewer stereotypical behaviours than do stabled horses, and may hence have improved welfare (McGreevy *et al.* 1995a, 1995b; Pell and McGreevy 1999; Parker *et al.* 2008). However, a pasture-based management system provides a unique set of management and welfare challenges compared with horses managed in stables (Rogers *et al.* 2007a).

The objective of this review is to examine the literature describing potential welfare issues related to pasture-based management of horses. The review will first cover the economic and perceived worth of the horse in the various equine sectors in relation to welfare considerations, before covering issues specifically related to the Thoroughbred racing industry. Finally, the broader welfare issues applicable to the management of horses used for sport and leisure will be discussed.

Pest to pet

Unlike other livestock industries where economic returns (sales price) can be clearly estimated on a standard per head basis, there is great variability in the economic value of horses among the different sectors of the equine industry, as well as large among-horse differences within the sectors. In a situation not unique to New Zealand, we find that the horse spans the spectrum from classification as a pest, to production animal, to companion animal (pet), and thus is subject to different levels of expectations based on economic and non-economic values. The classification of the horse within these categories generally depends on their primary function, or the sector of the equine industry (Fig. 1). Economic considerations in combination with perception of worth, generally drive the welfare and management of horses. Feral horses have a low marginal utility, and thus lower welfare consideration, whereas leisure and sport horses have a high marginal utility and perception of worth that is often disproportionate to their true economic value. This, in combination with more intensive management, causes leisure and sport horses to be held to higher welfare standards (New Zealand Government 2018).

The horse as a pest

The Kaimanawa horses, which are a small feral population of horses in the central plateau region of the North Island of New Zealand, provide a good example of this conflict in perception of worth. The Department of Conservation regard the feral

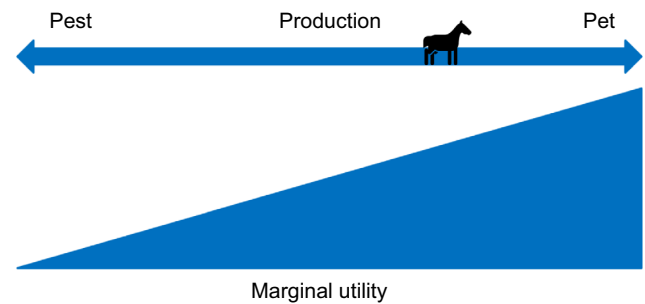


Fig. 1. Schematic representation of the relationship of marginal utility (and corresponding welfare expectation) and production sector for horses.

horse population as pests, because over-grazing places unnecessary pressure on a delicate subalpine ecosystem (Rogers 1991). To alleviate pressure on the ecosystem, selective musters and culls of the population have been conducted biannually, or at a frequency that allows the herd numbers to be maintained at ~300 (Department of Conservation 2012). These musters address a secondary aim of the Department of Conservation to improve the welfare state of the remaining horses. Without natural predators, the herd would continue to grow, resulting in over-population and increased pressure on grazing resources, leading to reduced welfare of all the horses (Linklater *et al.* 2000; Cameron *et al.* 2001).

Horses were initially culled as part of the muster; however, for a sector of society, these feral horses are regarded as a 'national treasure' that must be maintained (Jones 2011; Scasta *et al.* 2020). There are now rehoming programs, run by charities, for suitable candidates after the musters. The unique aspect of the management of the feral Kaimanawa horses is the cooperation of the federal government (Department of Conservation and New Zealand Army) and advocacy groups (Kaimanawa Heritage Horses and Kaimanawa Wild Horse Protection Society) in the management strategy of the feral horse herd and the local environment (Scasta *et al.* 2020). Previously, all horses unable to be rehomed after the muster were sent to slaughter; however, in recent musters there has been sufficient demand for horses to alleviate the need for the processing of unwanted horses, due in part, to campaigning and fundraising of Kaimanawa horse training and competition events.

Although considered a pest species, the Kaimanawa horses are protected under the Animal Welfare Act (New Zealand Government 2022) both in their feral state and after the muster. However, different sections of the Act, with differing welfare standards, pertain to the horses in their feral or domestic (post-mustered) state. Furthermore, Kaimanawa and other feral horses are covered only by the Code of Welfare for Horses and Donkeys (New Zealand Government 2018) after the muster, once they are under human care. The Code of Welfare for Horses and Donkeys expands on the obligations in the Animal Welfare Act and includes both

minimum standards and recommended best practices for equine welfare.

The horse as a production animal and pet

In New Zealand, racehorses, but also in some instances sport horses, fall into the category of production animals. The marginal utility of production animals is typically related to the return on the investment provided by these horses. Many leisure and sport horses tend to be classified somewhere in between a production animal and a companion animal. Horses regarded as companion animals (pets) tend to have a disproportionately high marginal utility, linked to the high emotive value owners place on their pets and not related to their true economic value.

Economic worth versus marginal utility of the horse

The position of the horse on the scale of marginal utility (Fig. 1) is nevertheless transient. Data from Ireland demonstrated a clear association between the success of the national economy and horse production (Fig. 2a, b). During 2005–2008, while the economy was buoyant (Celtic Tiger), the number of Thoroughbred and sport-horse foals born in Ireland remained constant. In contrast, after the global financial crisis, and as the national debt increased from 2008 (Fig. 2b), there was a dramatic increase in the number of horses sent to the abattoir, and a rapid decrease in the number of foals born (Leadon *et al.* 2012). These results suggest that the marginal utility of the same type of horses shifted as a result of the changes in the economic climate.

In the current global climate of constant worldwide media and social media access with graphic images, welfare concerns, particularly in the racing or production sectors, may be temporally influenced by a sector of society with little to no equine knowledge (Legg *et al.* 2019). The views of this

previously naïve sector of society may be in stark contrast to participants within the equine industry, but targeted media coverage can greatly influence the perceived worth of the horse and thus acceptable welfare standards. These changing pressures influence governing bodies to alter the welfare and perceived worth of the horse through the industry's social licence to operate (Heleski *et al.* 2020).

Welfare and the racing industry

Within New Zealand, the racing industry is the most well documented equine industry (Gee *et al.* 2020; Rogers *et al.* 2017b; Legg *et al.* 2021). This is partly due to the clear organisational structure of the breeding and racing of Thoroughbreds and Standardbreds in New Zealand (Bolwell *et al.* 2020; Chin *et al.* 2022). In contrast to many other countries, the Thoroughbred industry within New Zealand is heavily focused on commercial production, with ~40% of the foal crop exported either as yearlings or as early racing-product (2-year-old racehorses; Fennessy 2010; Legg *et al.* 2021). This large commercial focus leads to the consideration of the horse as a production animal and a focus on return of investment. The international commercial niche occupied by the New Zealand Thoroughbred is a later-maturing horse best suited for the classic 3-year-old races and middle distance to staying races. Given this niche, and the commercial export focus, pasture-based production provides a cost-effective production system with the advantage of providing the opportunity for positive stimuli on the musculoskeletal system (Rogers *et al.* 2012b, 2017a; Rogers and Dittmer 2019).

In New Zealand, racing broodmares usually foal at pasture in small cohorts. Both foals and mares will usually remain in these paddock cohorts until weaning. The process of weaning is a stressful event in a foal's development (Waran *et al.* 2008). The stress of weaning has been associated with increased

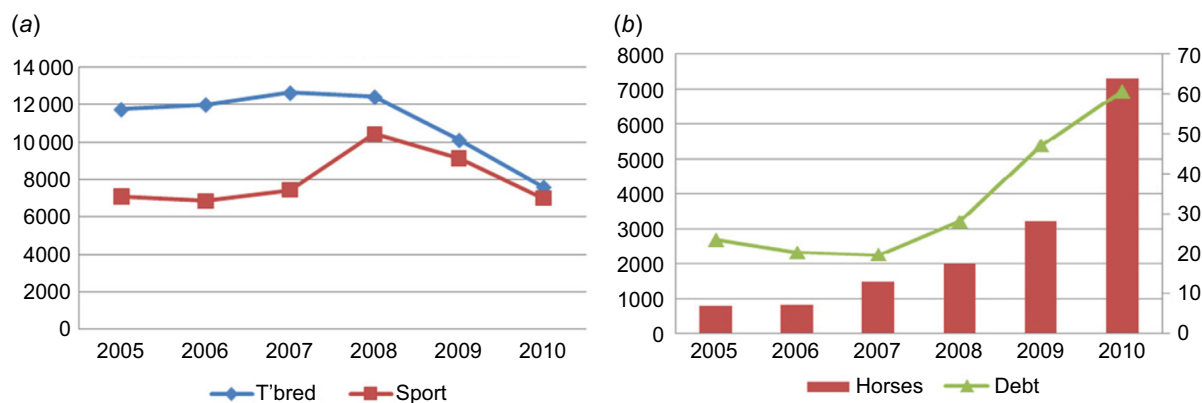


Fig. 2. (a) A representation of the number of Thoroughbred and Sport-horse foal births between 2005 and 2010 in Ireland. (b) A representation of the total horse numbers slaughtered and total central government debt percentage of gross domestic product in Ireland (as presented by Leadon *et al.* 2012).

susceptibility to infectious disease (Adams and Horohov 2013), risk of injury (Apter and Householder 1996), decrease in daily liveweight gain (Rogers *et al.* 2004a) and development of stereotypic behaviours (Nicol 1999). In New Zealand, at a mean age of 5 months, most Thoroughbred foals are box-weaned in cohorts; they are removed from their dams and housed, singularly or pairwise, in looseboxes for the duration of the weaning (1–2 weeks; Rogers *et al.* 2007a, 2017b). The pasture-based management system in New Zealand also allows for paddock weaning. Mares can be sequentially removed from the herd, including their foals, every 1–3 days or all mares can be abruptly removed, leaving a cohort of foals sometimes accompanied by a non-lactating mare as company. The method of weaning (progressive or abrupt) showed no effect on post-weaning average daily weight gain either short term, 10 days after weaning, or long term up to 480 days of age (Rogers *et al.* 2004b).

Public perception of racehorse welfare

The public concern for welfare of racehorses appears to be largely focused on Thoroughbred racing itself, and concerns directly related to racing, rather than issues relating to the growth and development of the racehorse. The focus from lobby groups and issues highlighted in public press and social media have tended to focus on emotive statements about immature horses, whipped to perform, catastrophic injuries, the number of horses sent to slaughter post-racing and the risk to horses from falling in jumps races (Legg *et al.* 2019; Heleski *et al.* 2020). However, discussion around racing in New Zealand media appears minimal and short-lived, typically sparked by an adverse event that is publicised, indicating that racehorse welfare is not a high priority for mainstream New Zealand public (Legg *et al.* 2019). Public concern tends to focus on Thoroughbred racing more than Standardbred racing, possibly due to a lower public profile and lower incidence of fatalities in Standardbred racing (Gibson *et al.* 2022b).

Two-year-old racing

The optimisation of the equine musculoskeletal system and impact of 2-year-old racing on horse welfare and health has been discussed in detail in a number of reviews (Rogers and Dittmer 2019; Rogers *et al.* 2020). In contrast to the proclamations from the lobby groups, and what appears to be a perception that has permeated even the non-racing equestrian press, there is a positive association of 2-year-old training and racing, with proxy measures of musculoskeletal health such as career length, number of race starts and prize money earned (Tanner *et al.* 2011, 2013; Flash *et al.* 2022). This association appears dose dependent, with the positive association increasing with the level of activity (racing vs just being in training) as a 2-year-old. This association makes physiological sense as the application of training load is provided when the musculoskeletal system is at its most

responsive. The positive associations between early age of entry to training and competition on career length have also been observed in show jumping, dressage and event horses (Rogers *et al.* 2012a).

Whip use

The use of the whip in Thoroughbred racing has proven a contentious issue (Marshall 2008; Smith 2009). The jockey is faced with a balancing act; if the whip is not used and the horse fails to win or place, then they may be charged with failing to ride a horse to its merits, while too much use of the whip, or inappropriate use of the whip, results in a welfare issue and disciplinary action from the racings regulatory body (New Zealand Thoroughbred Racing 2021).

In response to animal-welfare concerns, and as a pragmatic approach, the padded whip has been implemented in Thoroughbred racing in a number of countries. On 1 August 2009, padded whips became mandatory in New Zealand, bringing the country on par with nations such as Australia, India, Ireland and United Kingdom. However, robust research into the effectiveness and the welfare implications of these whips is lacking. In 2011, The British Horseracing Authority (BHA) conducted a review of the whip use in horseracing (BHA 2011). An analysis by Jones *et al.* (2015) criticised the report's conclusion that whip use in racing is not a welfare problem, that it does not cause pain and that whip use is necessary for encouragement and safety. The primary driver for the poor critique of the BHA report on whip use was the consistent lack of adequate scientific evidence to support these claims (Jones *et al.* 2015). However, both the report by BHA and Jones *et al.* (2015) identified that there were no studies that had objectively and directly assessed horse welfare in relation to whip use in races.

In addition to restrictions on type of whip used, the guidelines of Thoroughbred racing in New Zealand further state that riders cannot strike a horse forward of its shoulder, carry more than one whip and should never 'strike a horse with a whip in a manner or to an extent which is: (i) unnecessary (ii) or excessive (iii) or improper' (rule 638, pp. 94–95) (New Zealand Thoroughbred Racing 2021). The wording in regard to the manner of which a horse can be struck is somewhat more subjective and open to interpretation than in the equivalent rules in Australia and the United Kingdom. The racing guidelines in Australia (AR132, pp. 66–67) and the United Kingdom (rule (F)45) are more detailed in terms of whip use and clearly state that appropriate use of the whip is to be considered within the context of the horse's ability to respond and improve/maintain its position within the race (New Zealand Thoroughbred Racing 2021; Racing Australia 2022). Current revision of the whip-use rules in the United Kingdom requires the whip to be used in the only backhand (as opposed to the forehand) position, effectively limiting the force with which a jockey is able to strike the horse (rule (F)45) (British Horseracing Authority 2022).

The effectiveness of the whip on velocity during racing is also questionable, with only one study having examined this question. [Evans and McGreevy \(2011\)](#) reported that horses achieved highest velocity when whip use was absent, and whip use was most frequent in fatigued horses ([Evans and McGreevy 2011](#)). The need for the use of the whip to maintain racing integrity may also have limited merit, with one study identifying no differences in stewards reports of events between whip-free and whipping-permitted races ([Thompson et al. 2020](#)).

Injuries associated with racing

A focal welfare concern of the racing industry is the risk of injury during training and racing. The primary reason for involuntary loss of horses from racing and lost training days is musculoskeletal injury (lameness), followed by respiratory conditions ([Perkins et al. 2005](#); [Gibson et al. 2022b](#)). These reasons are not unique to racing and were also reported in other industries such as show jumping, and even within lower-intensity activities such as riding school horses ([Lönnell 2012](#); [Lönnell et al. 2012](#)). Most lost training days in racing are associated with 2-year-old horses, and the primary reason for lost training days relates to dorsal metacarpal disease (bucked shins or shin soreness; [Perkins et al. 2005](#)). Dorsal metacarpal disease relates to the rapid response of naïve bone to the loads of gallop exercise ([Nunamaker et al. 1990](#); [Firth et al. 2005](#)). There are now robust physiological and epidemiological data providing a framework on how the early introduction of only a few high-speed load cycles (gallop strides in Thoroughbreds) early in the racing preparation can reduce the risk of dorsal metacarpal disease ([Firth et al. 2005](#); [Verheyen et al. 2005](#)).

For older racehorses, injury prevention focuses on mitigating the risks associated with the accumulation of training load cycles. The tissues most sensitive to this are bone (fracture), tendon (strain and rupture) and cartilage (osteoarthritis) ([Rogers et al. 2012b, 2020](#)). The failure of bone relates to the cyclic overload of the tissue and thus it is primarily due to inappropriate timing of load cycles and timing of periods of rest and tissue recovery ([Martig et al. 2014](#); [Bogers et al. 2016](#)). In contrast, both cartilage and tendon have very low rates of tissue turnover and the integrity of the tissue reduces with age and number of load cycles. Thus, the challenge for the trainer is how to optimise fitness, while minimising risk of injury ([Rogers et al. 2007b, 2012b](#)). Within Australasia, the conceptual approach has been to provide maximal fitness from minimal training load (an efficiency approach) in an attempt to reduce the risk profile to training load ([Rogers et al. 2007b](#); [Bolwell et al. 2010](#); [Morrice-West et al. 2020](#)). In contrast, racehorse trainers in the United Kingdom characteristically use large volume of training load to achieve maximal fitness, so as to reduce risk to injury ([Verheyen et al. 2006](#)).

The rate of catastrophic injury within Thoroughbred flat racing and Standardbred racing in New Zealand appears low, compared with other racing jurisdictions ([Hitchens et al. 2019](#); [Gibson et al. 2022a, 2022b](#)). This is possibly an interaction of the early production process, the pattern of racing and the ability, or willingness, of trainers and owners to spell horses at regular intervals ([Bolwell et al. 2013](#); [Legg et al. 2021](#)). Most trainers in New Zealand provide early training to 2-year-olds, with the primary goals of development and education, which should prime the musculoskeletal system for future challenges ([Bolwell et al. 2010](#)). The consistency of the racing calendar also provides flexibility for many trainers to provide spells when required rather than being constrained temporally due to lack of appropriate racing opportunities ([Rosanowski et al. 2015](#)). New Zealand has low-risk racing surfaces, with predominantly turf race tracks and few races (~3%) on tracks classified as the going being fast (penetrometer, 2.0–2.5), with the going at most meetings being consistent and rated as good or dead ([Rogers et al. 2014](#); [Legg et al. 2021](#)).

Wastage and life after racing

The loss or 'wastage' of racehorses is often considered one of the industries foremost welfare concerns. The median racing career for Thoroughbreds is nine (IQR 4–19) races, with three (IQR 2–3) preparations over a 2–3-year period ([Legg et al. 2021](#)), and, after lack of talent, the major reason for loss from the racing industry is musculoskeletal injury ([Rogers et al. 2017b](#); [Shrestha et al. 2021](#)). There is also wastage due to the failure of Thoroughbred foals born to progress through to racing ([Bailey et al. 1997](#); [Wilsher et al. 2006](#); [Tanner et al. 2013](#)), with 33% failing to be registered with a trainer ([Tanner et al. 2013](#)). Approximately 40% of the racing population of horses exit the industry each year in New Zealand, similar to the value from preliminary investigation of Thoroughbreds in Australia ([Thomson et al. 2014](#); [Legg et al. 2021](#)). More detailed investigation in Australia identified that 43% of these horses were, in reality, reported to still be actively participating in the industry, through spelling or training with unlicensed trainers, with a more accurate retirement metric being 17% retirements and 2.1% deaths per year ([Shrestha et al. 2021](#)). The median age of retirement of horses in both New Zealand and Australia is 5 years old ([Legg et al. 2021](#); [Shrestha et al. 2021](#)).

The outcome for horses exiting the racing industry in New Zealand is largely unknown; however, due to the similarities between the racing industries in Australia and New Zealand, parallels may be drawn. The most frequently reported activities undertaken by retired Thoroughbred racehorses in Australia in the 2017–2018 season were equestrian or pleasure horse activities (45%), followed by participation in Australian bloodstock (30%), with only 6% of horses with unknown fates ([Shrestha et al. 2021](#)). Evidence in New Zealand supports the high rate of repurposing of retired racehorses as sport or leisure horses. Data collected suggest that approximately 45%

of leisure horses and up to 55% of intermediate-level sport horses in New Zealand are described as Thoroughbred or Thoroughbred crosses (Rogers and Vallance 2009; Verhaar *et al.* 2014). Moreover, approximately 89% of horses competing in eventing in New Zealand are reported to be Thoroughbreds (Rogers and Firth 2005).

Traditionally there has been some laxity in the record of the official retirement of horses from racing. Since 2015, it has been mandatory for the retirement or reason for a horse to cease racing to be officially recorded (Rule 417; New Zealand Thoroughbred Racing 2021). As these data accumulate, it will become easier to identify the outcome and subsequent life after racing for these horses. Another difficulty encountered by the racing industry is the lack of national regulatory requirement to register horses in New Zealand, and the high turnover of recreation horses among owners. The industry also faces the challenge that if there is a welfare or management issue with a Thoroughbred, that the horse is often described as an 'ex-racehorse'. This descriptor associates or implies that the racing industry is directly liable or culpable for the care of the horse throughout its life. In reality, many of these horses may have had a number of owners not associated with racing and in many situations, may have spent the majority of their lives associated with non-racing ownership and activities.

Welfare and the leisure- and sport-horse sector

Leisure and sport horses represent the largest proportion of the equine industry in New Zealand (Rosanowski *et al.* 2012b). Information regarding the health and welfare of these horses is, nevertheless, scarce (Fernandes *et al.* 2015). In contrast to the level of recording in the racing industry, the documentation of the production processes and number of participants in the leisure- and sport-horse industry is less robust (Rogers and Firth 2005).

Documentation/biosecurity

In contrast to Europe, where all horses are required to obtain a passport or formal identification, there is no legal requirement to record horses with a registry or central database in New Zealand (Simmons 2015). The lack of documentation of the number of leisure horses may be considered a potential welfare issue. A lack of knowledge of the number and distribution of horses can have large implications in the event of a disease outbreak (Rosanowski *et al.* 2012b, 2019). For example, in Australia, the presence of a naïve equine population and a lapse in border biosecurity led to a rapid and widespread outbreak of equine influenza (Callinan 2008). The lack of information of numbers and distribution of horses in New Zealand could make containing such an outbreak difficult, and it is hence possible that a large number of horses could contract such an infection.

The movement of broodmares around New Zealand has long been recognised as a likely facilitator of the spread of infectious disease (Rogers and Cogger 2010). Improved biosecurity practices on equine properties can be an effective barrier to avoid transmission of infectious disease when horses are moved onto farms (Gildea *et al.* 2011). However, Rosanowski *et al.* (2013) reported that when 60 stud farms in New Zealand were surveyed, few biosecurity practices were identified and in the event of an infectious disease outbreak, the practices would be inadequate at preventing disease transmission. The risk of lax biosecurity practices intensifies with the high frequency of horse and people movement among stud farms in New Zealand (Rosanowski *et al.* 2013).

Daily management

It is possible that pasture-based management systems are more forgiving for shortcomings in management than are intensively managed stabled horses. Surveys conducted in the UK and Australia have identified concerns with the nutritional management of leisure and sport horses associated with the prevalence of behavioural problems (Buckley *et al.* 2013; Ireland *et al.* 2013). Although published information on the topic is limited, similar welfare concerns have not been reported in New Zealand. Fernandes *et al.* (2014) reported that 80% of Pony Club horses surveyed had 24-h access to pasture year round, which is similar to the management of sport horses in New Zealand (Verhaar *et al.* 2014).

As a herd-centric species, horses are sensitive to stress associated with social isolation (Reid *et al.* 2017). In contrast to intensive housing systems, pasture-based management is less likely to be associated with social isolation. However, 46% of sport horses in a cross-sectional survey were reported to be kept on their own when at pasture, possibly reflecting a management strategy intended to reduce the opportunity for injury associated with horses interacting and playing with conspecifics when at pasture (Verhaar *et al.* 2014).

Horses managed on pasture have lower incidents of abnormal and stereotypical behaviour than do intensively managed stabled horses (McGreevy *et al.* 1995a; Parker *et al.* 2008). The lower incidences of abnormal and stereotypical behaviour observed in pasture-managed horses may be due to the opportunity to express a wider range of normal behaviours than in stabled horses (McGreevy 1997). Stereotypical behaviour in horses has been linked to a number of negative characteristics and is generally considered a sign of reduced welfare (Cooper and McGreevy 2002).

Pasture-specific welfare issues

Equine obesity has been highlighted as a welfare issue of epidemic proportions in North America, UK and Australia, affecting 30–60% of leisure horses (Buckley *et al.* 2013; Giles *et al.* 2014; Robin *et al.* 2015). A similar trend appears to be present in New Zealand Pony Club horses. A preliminary

study by [Fernandes et al. \(2014\)](#) reported that 22% of Pony Club members in New Zealand scored their horse with a body condition score (BCS) of $\geq 7/9$ ([Henneke et al. 1983](#)). A subsequent study by the same authors reported that when BCS of Pony Club horses was scored by a trained scorer, 47% were scored as 'fat' (BCS $\geq 7/9$) and 25% presented with a cresty-neck score $\geq 3/6$ ([Fernandes et al. 2015](#)). Ponies are efficient feed converters enabling them to maintain or gain body condition if pasture is offered *ad libitum* ([Dugdale et al. 2011](#)). Restricting feed intake while in a pasture-based system can be difficult because it is possible for ponies to consume over 100% of their daily energy need within 3 h at pasture ([Longland et al. 2016](#)). Obesity in horses can potentially lead to a number of health and welfare issues such as thermoregulatory inefficiency ([Cymbaluk and Christison 1990](#)), abnormal reproductive performance ([Fitzgerald et al. 2003](#)), colic ([Garcia-Seco et al. 2005](#)) and laminitis ([Field and Jeffcott 1989](#)).

Perennial ryegrass is common in New Zealand pasture ([Charlton and Stewart 1999](#)) and although seasonal variations occur, perennial ryegrass generally has a high sugar content ([West et al. 2002](#)). Horses, and especially ponies, are more prone to develop laminitis if they are managed on high-sugar pasture ([Avery 1997](#)). Interestingly, only 10% of the owners reported that their horses were prone to laminitis in the survey by [Fernandes et al. \(2015\)](#). This may imply some adaptation to the consistent availability of high-sugar pasture, that pasture restriction protocols attenuated the risk, or an inability of owners to identify subtle signs of laminitis.

If perennial ryegrass is infected by *Acremonium lolii*, the consumption of ryegrass can cause ryegrass staggers ([Latch et al. 1984](#)). Ryegrass staggers are prevalent in New Zealand ([Gilruth 1906](#); [Cunningham and Hartley 1959](#)) and the behavioural and physiological symptoms can pose an welfare threat to the animal ([Johnstone and Mayhew 2013](#)). There are a number of products marketed to alleviate the symptoms of ryegrass staggers and the sales volume of these would indicate a concern within the sport-horse industry that ryegrass staggers may have a competition/performance-limiting effect. However, there is currently limited published information on the prevalence and management of ryegrass staggers in New Zealand horses.

Health care regulations

At present, there is no legislation requiring formal qualifications for an individual to work as a farrier in New Zealand. This is also the case in many countries with the exception of the UK where all farriers must register with the Farriers Registration Council. Farriers in New Zealand have the option to join The New Zealand Farriers Association (NZFA), which provides training and qualifications as well as promoting standards of hoof care and farriery. In a survey by [Dijkstra et al. \(2016\)](#), it was

reported that approximately 50% of sport horses surveyed in New Zealand are shod by a farrier with qualifications recognised by the NZFA. Despite the farriery industry being largely unregulated, measurements of hoof morphology by the same authors showed a positive level of foot balance for most sport horses. Limited data are available regarding hoof health of sport and leisure horse in New Zealand; however, widespread anecdotal reports suggest a low prevalence of welfare issues. This may be attributed to the reportedly good inter-relationship between farriers and veterinarians when working on orthopaedic issues ([Dijkstra et al. 2016](#)).

In contrast to the team approach used with farriers and veterinarians, the co-ordination of treatment between veterinarians and allied health practitioners (such as equine physiotherapists, osteopaths, chiropractors and massage therapists) appears to be lacking ([Meredith et al. 2011](#)). A more holistic team approach to managing leisure and sport horses currently appears restricted to riders at the elite level ([McGowan et al. 2007](#)). Allied health therapists, mainly chiropractors (37%) or physiotherapists (24%), are nevertheless commonly used by all level of riders in New Zealand (~68% of dressage and show jumping riders). Within New Zealand, literature and legislation regarding the qualifications required for the various allied health therapies are often lacking ([Meredith et al. 2011](#)), and many riders and trainers were reportedly not aware whether their therapist was trained (22%) or had a formal qualification (49%). A previous study by [Coleman et al. \(2006\)](#) reported that only 44% of equine alternative therapists surveyed held a formal qualification or certificate. The skill level of a practitioner without formal qualifications cannot be guaranteed. It is of concern that over 50% of practitioners may not be adequately trained and thus pose a potential welfare risk to their equine clients.

The lack of strict regulations and quantification of efficiency of treatments may be a driver as to why few veterinarians choose to co-ordinate their treatments plan with non-veterinary practitioners. [Meredith et al. \(2011\)](#) reported that the main reasons for using an allied health therapist in New Zealand were to treat back pain (36%) and lameness (25%). Back pain and lameness are often inter-related ([Landman et al. 2004](#); [Murray et al. 2010](#)) and, as such, could perhaps benefit from a team approach treatment plan. Stricter regulation of allied health practitioners, and continued research into the effectiveness of such treatments, could improve inter-relationship among veterinarians, farriers and allied health therapists and, subsequently, the welfare of horses.

Preventative health care

Previous surveys have reported that the frequency of providing preventative healthcare, such as administration of anthelmintic and dental examinations, in New Zealand is

high (Rosanowski *et al.* 2012a; Fernandes *et al.* 2014). Nevertheless, frequent use of anthelmintic is potentially a long-term welfare concern because of overuse, or non-surveillance based drenching methods, and the development of anthelmintic resistance. It is now internationally accepted within the scientific community that the traditional approach to parasite control of administering re-occurring anthelmintic treatments with consistent intervals has contributed to the development of resistance (Lloyd *et al.* 2000; Kaplan 2002, 2004; Nielsen 2009). In addition, the development of new anthelmintics is a long and complex process. The growth of anthelmintic resistance is a concern to the equine industry as the problem has been reported worldwide (Kaplan 2004), including in New Zealand (Bishop *et al.* 2014).

Fernandes *et al.* (2014) reported that the use of vaccinations in Pony Club Horses was low compared with international standards (e.g. Ireland *et al.* 2013). It has been suggested that the low rate of vaccination is due to the low prevalence of infectious equine disease in New Zealand (Horner 1989). In the event of an infectious disease outbreak in New Zealand, the low vaccination rates (and high level of horse movement, paired with poor biosecurity on farms) may result in poor containment of the disease. In addition, low vaccination rates mean that many horses may have limited interaction with veterinarians, unless they become ill, since annual vaccinations are uncommon. Limited contact with veterinarians may result in potential health risks of diseases in horses not being identified early, especially among naive owners and if symptoms are vague or subtle.

Ireland *et al.* (2013) reported that 32% of horses in the United Kingdom had a chronic or recurrent health condition. A similar trend has not been reported in New Zealand. The management of horses on pasture appears to be associated with a lower frequency of health problems such as respiratory conditions and colic than in stabled horses (Perkins *et al.* 2005). Alternatively, health problems, such as those reported by Fernandes *et al.* (2014, 2015), may be under-reported in surveys, because owner-reported frequency may be subject to recall bias, and has been described to differ from that reported by a veterinarian (Ireland *et al.* 2012a). The true prevalence of health problems such as laminitis and colic in New Zealand leisure and sport horses are hard to predict without more robust quantitative data collection.

Welfare of geriatric horses

Anecdotal evidence suggests that the population of geriatric horses is growing and that their needs and risk factors may differ from younger horses (Ireland *et al.* 2011). With cost-effective pastoral management systems, owners may be more inclined to allow aged and/or retired horses to 'live out their days'. Pasture-based horses are likely to be monitored less intensively and it is hence possible that early signs of poor welfare may be missed (McGowan 2011). If health problems are not identified early, the welfare of the horse

could be suffering. Poor agreement of owner-reported illness compared with that detected by a veterinarian has been reported and suggests inaccurate or under-recognition of welfare problems by owners of geriatric horses (McGowan *et al.* 2010; Ireland *et al.* 2012a, 2012b).

Euthanasia

In New Zealand, the Animal Welfare Act 1999 (New Zealand Government 2022) states that 'the owner of an animal that is ill or injured, and every person in charge of such an animal, must ensure that the animal receives treatment that alleviates any unreasonable or unnecessary pain or distress being suffered by the animal' (section 9, p. 24). Humane euthanasia is performed on an emergency basis or elective. The first is due to an emergency situation where the horse is seriously ill or injured, such as broken limbs. The second situation is due to longer-term problems, such as age-related ailments or chronic injuries. The act of leaving a suffering animal to die of natural causes is considered to be unacceptable. Therefore, quality-of-life assessment may play an important role in informing euthanasia decisions (McGowan and Ireland 2016). Increased veterinary education and involvement and improved owner information and education could facilitate and aid management of welfare problems and quality-of-life assessment (Littlewood *et al.* 2021).

In New Zealand, there are no records of the number of horses euthanised annually and the act of euthanasia is poorly regulated. In many regions within New Zealand, horses can either be euthanised and buried on the farms where they lived, although a number of regional councils now prohibit this practice, because of concerns over environmental contamination with the barbiturates, and the impact on ground water. These disposal restrictions have been associated with an increasing number of commercial cremation businesses that service the equine industry.

Other common end-of-life options include sending horses to hunt clubs, or sent to pet food manufacturers (Rogers *et al.* 2016). Only a licenced veterinarian is authorised to euthanise a horse by lethal injection (generally sodium pentobarbital). The other methods of euthanising horses are with a firearm or a captive bolt gun. No certification is needed to euthanise animals using these two methods. However, there are Codes of Welfare stating that horses must be 'euthanised in a manner that minimises pain and distress and the personnel undertaking the euthanasia must be competent in handling and killing horses' (part 9, p. 31: New Zealand Government 2018). However, these standards are vague and likely to be difficult to enforce, especially for horses euthanised on farms by a layperson.

There are approximately 27 pet food manufacturers in New Zealand. Pet food manufacturers are not required to release the number of horses processed per year. However, one manufacturer reported that they received ~25–30 horses annually for processing (Rogers *et al.* 2016). Historically, in

New Zealand, there was only one slaughter plant processing horses for human consumption, and all meat was exported. This plant processed 1530 and 1175 horses in the years 2013–2014 and 2014–2015 respectively (Ministry of Primary Industries 2016). Since 2020, this abattoir has not renewed its licence for processing horses for human consumption.

Transition from the five freedoms to the five domains

In recent years, there has been a transition from consideration of horse welfare in the context of minimising noxious or unpleasant stimuli or environmental conditions to promotion of a positive affective state. The five domains model considers both the physical and mental domains of nutrition, health, environment, behaviour and human interaction of the horse, taking into account aspects of both welfare compromise and enhancement from each domain on the overall affective state of the horse (Mellor and Beausoleil 2015). The model highlights that in addition to providing for the basic physical and behavioural needs of the horse, positive experiences (such as free movement, varied and engaging environmental challenges and clear, consistent training) can add to increasing the mental state of the horse.

Within New Zealand, the Thoroughbred racing industry has been the first to adopt this change, with the domains concept providing the underpinning of the Thoroughbred racing code of welfare (Mellor and Burns 2020). One of the challenges with this approach has been the identification of clear discrete measures of a positive affective state, which often require a holistic assessment, in contrast to negative states, which often can be identified by single markers or measures of discomfort (Bell *et al.* 2019). The domain approach also requires a strong reference point of the evolutionary ecological niche of the horse to avoid the temptation for anthropomorphism.

Conclusions

In conclusion, pasture-based systems, such as those in New Zealand, may result in fewer welfare issues than does intensive management (stabling) of horses. The perceived worth (both economic and emotive value) of the horse drives both management and welfare considerations for the horse, and may fluctuate depending on where the horse is situated on the marginal utility spectrum. The pasture-based production system appears to have long-lasting benefits to Thoroughbred racehorses raised within this environment, both during their career (owing to weaning practices, early exercise, and training opportunities, minimising injury risk), and in their subsequent retirement and repurposing as sport and leisure horses. However, the present challenge is the lack of information on some management strategies, particularly in the sport- and leisure-horse sector. The limited reporting in these areas may

allow welfare issues to go largely unnoticed. Greater documentation of the industry participants, their location and production processes would permit greater clarity on the focus for further equine-welfare research priorities.

References

- Adams AA, Horohov DW (2013) The effect of an immunomodulator (parapoxvirus ovis) on cell-mediated immunity (CMI) in abruptly weaned foals. *Veterinary Immunology and Immunopathology* **153**, 118–122. doi:10.1016/j.vetimm.2012.11.020
- Apter RC, Householder DD (1996) Weaning and weaning management of foals: a review and some recommendations. *Journal of Equine Veterinary Science* **16**, 428–435. doi:10.1016/S0737-0806(96)80208-5
- Avery A (1997) 'Pasture for Horses; a winning resource.' (Gillingham Printers Ltd: Adelaide, SA, Australia)
- Bailey CJ, Rose RJ, Reid SW, Hodgson DR (1997) Wastage in the Australian thoroughbred racing industry: a survey of Sydney trainers. *Australian Veterinary Journal* **75**, 64–66. doi:10.1111/j.1751-0813.1997.tb13836.x
- Bell C, Rogers S, Taylor J, Busby D (2019) Improving the recognition of equine affective states. *Animals* **9**, 1124. doi:10.3390/ani9121124
- BHA (The British Horseracing Authority) (2011) A review of the use of the whip in Horseracing. Available at <http://www.britishhorseracing.com/wp-content/uploads/2014/03/WhipReview.pdf> [accessed 1 June 2022]
- Bishop RM, Scott I, Gee EK, Rogers CW, Pomroy WE, Mayhew IG (2014) Sub-optimal efficacy of ivermectin against *Parascaris equorum* in foals on three Thoroughbred stud farms in the Manawatu region of New Zealand. *New Zealand Veterinary Journal* **62**, 91–95. doi:10.1080/00480169.2013.843146
- Bogers SH, Rogers CW, Bolwell C, Roe WD, Gee EK, McIlwraith CW (2016) Quantitative comparison of the bone mineral density characteristics of third metacarpal distal epiphyses with and without condylar fracture. *American Journal of Veterinary Research* **77**, 32–38. doi:10.2460/ajvr.77.1.32
- Bolwell CF, Russell LJ, Rogers CW (2010) A cross-sectional survey of training practices of 2-year-old racehorses in the North Island of New Zealand. *Comparative Exercise Physiology* **7**, 37–42. doi:10.1017/S1755254010000103
- Bolwell CF, Rogers CW, French NP, Firth EC (2013) The effect of interruptions during training on the time to the first trial and race start in Thoroughbred racehorses. *Preventive Veterinary Medicine* **108**, 188–198. doi:10.1016/j.prevetmed.2012.08.010
- Bolwell CF, Rogers CW, Gee EK, Rosanowski SM (2020) Commercial equine production in New Zealand. 3. The racing and sport industries. *Animal Production Science* **60**(18), 2164–2174. doi:10.1071/AN16753
- British Horseracing Authority (2022) Revised Penalty Framework. Available at <https://www.britishhorseracing.com/regulation/the-whip-2/#:~:text=The%20whip%20may%20only%20be,the%20welfare%20of%20the%20horse> [accessed 18 October 2022]
- Buckley P, Morton JM, Buckley DJ, Coleman GT (2013) Misbehaviour in Pony Club horses: incidence and risk factors. *Equine Veterinary Journal* **45**, 9–14. doi:10.1111/j.2042-3306.2011.00541.x
- Callinan I (Ed.) (2008) 'Equine influenza: The August 2007 outbreak in Australia. Report of the Equine Influenza Inquiry.' (Attorney-General's Department, Commonwealth of Australia: Canberra, ACT, Australia). Available at <http://www.equineinfluenzaenquiry.gov.au/eiexhibits/REP.0001.001.0001.pdf>
- Cameron EZ, Linklater WL, Minot EO, Stafford KJ (2001) Population dynamics 1994–98, and management, of Kaimanawa wild horses. Department of Conservation, Wellington, New Zealand. Available at <http://www.doc.govt.nz/Documents/science-and-technical/sfc171.pdf> [accessed 25 August 2016]
- Charlton JFL, Stewart AW (1999) Pasture species and cultivars used in New Zealand – a list. *Proceedings of the New Zealand Grassland Association* **61**, 147–166.
- Chin YY, Rogers CW, Gee EK, Stafford KJ, Cameron EZ (2022) The pattern of breeding and management within the New Zealand Thoroughbred

- breeding industry 2005–2015. 1. The stallion population. *Animal Production Science*. doi:10.1071/an21388
- Cohen ND, Gibbs PG, Woods AM (1999) Dietary and other management factors associated with colic in horses. *Journal of the American Veterinary Medical Association* 215, 53–60.
- Coleman HJ, Rogers CW, Gee EK (2006) The use of alternative therapies in racing Thoroughbreds. *Proceedings of the New Zealand Society of Animal Production* 66, 279–283.
- Cooper JJ, McGreevy PD (Eds) (2002) Stereotypic behaviour in the stabled horse: causes, effects and prevention without compromising horse welfare. In 'The welfare of horses'. (Kluwer Academic Press: Amsterdam, Netherlands)
- Cunningham LJ, Hartley WJ (1959) Ryegrass staggers. *New Zealand Veterinary Journal* 7, 1–7. doi:10.1080/00480169.1959.33317
- Cymbaluk NF, Christison GI (1990) Environmental effects on thermoregulation and nutrition of horses. *Veterinary Clinics of North America: Equine Practice* 6, 355–372. doi:10.1016/s0749-0739(17)30546-1
- Department of Conservation (2012) Kaimanawa wild horses working plan 2012–2017. Department of Conservation (Te Papa Atawhai), Wellington, New Zealand. Available at <http://www.doc.govt.nz/about-us/science-publications/conservation-publications/threats-and-impacts/animal-pests/kaimanawa-wild-horses-working-plan-2012-2017/> [accessed October 2022]
- Dijkstra AM, Sinnige TC, Rogers CW, Gee EK, Bolwell CF (2016) Preliminary examination of farriery and hoof care practices, and owner reported injuries in sport horses in New Zealand. *Journal of Equine Veterinary Science* 46, 82–88. doi:10.1016/j.jevs.2016.07.011
- Dugdale AHA, Curtis GC, Cripps PJ, Harris PA, Argo CM (2011) Effects of season and body condition on appetite, body mass and body composition in ad libitum fed pony mares. *The Veterinary Journal* 190, 329–337. doi:10.1016/j.tvjl.2010.11.009
- Evans D, McGreevy P (2011) An investigation of racing performance and whip use by jockeys in thoroughbred races. *PLoS ONE* 6, e15622. doi:10.1371/journal.pone.0015622
- Fennessy PF (2010) An overview of the New Zealand Thoroughbred Industry. *Proceedings of the New Zealand Society of Animal Production* 70, 137–139.
- Fernandes KA, Rogers CW, Gee EK, Bolwell CF, Thomas D (2014) A cross-sectional survey of rider and horse demographics, and the feeding, health and management of Pony Club horses in New Zealand. *Proceedings of the New Zealand Society of Animal Production* 74, 11–16.
- Fernandes KA, Rogers CW, Gee EK, Bolwell CF, Thomas D (2015) Body condition and morphometric measures of adiposity in a cohort of Pony Club horses and ponies in New Zealand. *Proceedings of the New Zealand Society of Animal Production* 75, 195–199.
- Field JR, Jeffcott LB (1989) Equine laminitis – another hypothesis for pathogenesis. *Medical Hypotheses* 30, 203–210. doi:10.1016/0306-9877(89)90062-5
- Firth EC, Rogers CW, Doube M, Jopson NB (2005) Musculoskeletal responses of 2-year-old Thoroughbred horses to early training. 6. Bone parameters in the third metacarpal and third metatarsal bones. *New Zealand Veterinary Journal* 53, 101–112. doi:10.1080/00480169.2005.36487
- Fitzgerald BP, Reedy SE, Sessions DR, Vick MM, Murphy BA (2003) Obesity disrupts the duration of the estrous cycle in the mare. *Journal of Animal Science* 81, 102.
- Flash ML, Crabb HK, Hitchens PL, Firestone SM, Stevenson MA, Gilkerson JR (2022) Factors associated with racing performance and career duration for Victorian-born Thoroughbreds. *Australian Veterinary Journal* 100, 48–55. doi:10.1111/avj.13128
- Garcia-Seco E, Wilson DA, Kramer J, Keegan KG, Branson KR, Johnson PJ, Tyler JW (2005) Prevalence and risk factors associated with outcome of surgical removal of pedunculated lipomas in horses: 102 cases (1987–2002). *Journal of the American Veterinary Medical Association* 226, 1529–1537. doi:10.2460/javma.2005.226.1529
- Gee EK, Rogers CW, Bolwell CF (2020) Commercial equine production in New Zealand. 1. Reproduction and breeding. *Animal Production Science* 60, 2145–2154. doi:10.1071/AN16728
- Gibson MJ, Legg KA, Gee EK, Rogers CW (2022a) Race-level reporting of incidents using an online system during three seasons (2019/2020–2021/2022) of Thoroughbred flat racing in New Zealand. *Animals* 12, 3028. doi:10.3390/ani12213028
- Gibson MJ, Legg KA, Gee EK, Rogers CW (2022b) Race-level reporting of incidents using the new online system during two seasons (2019/2020–2020/2021) of Harness Racing in New Zealand. *Journal of Equine Veterinary Science* 119, 104142. doi:10.1016/j.jevs.2022.104142
- Gildea S, Arkins S, Cullinane A (2011) Management and environmental factors involved in equine influenza outbreaks in Ireland 2007–2010. *Equine Veterinary Journal* 43, 608–617. doi:10.1111/j.2042-3306.2010.00333.x
- Giles SL, Rands SA, Nicol CJ, Harris PA (2014) Obesity prevalence and associated risk factors in outdoor living domestic horses and ponies. *PeerJ* 2, e299. doi:10.7717/peerj.299
- Gilruth JA (1906) Meningo-encephalitis (stomach staggers) in horses, cattle, and sheep. *Annual Reports from the New Zealand Department of Agriculture* 14, 293–297.
- Heleski C, Stowe CJ, Fiedler J, Peterson ML, Brady C, Wickens C, MacLeod JN (2020) Thoroughbred racehorse welfare through the lens of 'social license to operate' – with an emphasis on a US perspective. *Sustainability* 12(5), 1706. doi:10.3390/su12051706
- Henneke DR, Potter GD, Kreider JL, Yeates BF (1983) Relationship between condition score, physical measurements and body fat percentage in mares. *Equine Veterinary Journal* 15, 371–372. doi:10.1111/j.2042-3306.1983.tb01826.x
- Hitchens PL, Morrice-West AV, Stevenson MA, Whitton RC (2019) Meta-analysis of risk factors for racehorse catastrophic musculoskeletal injury in flat racing. *The Veterinary Journal* 245, 29–40. doi:10.1016/j.tvjl.2018.11.014
- Horner GW (1989) Infectious disease status of New Zealand horses. *Surveillance* 16, 14–16.
- Ireland JL, Clegg PD, McGowan CM, McKane SA, Pinchbeck GL (2011) A cross-sectional study of geriatric horses in the United Kingdom. Part 1: Demographics and management practices. *Equine Veterinary Journal* 43, 30–36. doi:10.1111/j.2042-3306.2010.00145.x
- Ireland JL, Clegg PD, McGowan CM, McKane SA, Chandler KJ, Pinchbeck GL (2012a) Comparison of owner-reported health problems with veterinary assessment of geriatric horses in the United Kingdom. *Equine Veterinary Journal* 44, 94–100. doi:10.1111/j.2042-3306.2011.00394.x
- Ireland JL, Clegg PD, McGowan CM, McKane SA, Chandler KJ, Pinchbeck GL (2012b) Disease prevalence in geriatric horses in the United Kingdom: veterinary clinical assessment of 200 cases. *Equine Veterinary Journal* 44, 101–106. doi:10.1111/j.2042-3306.2010.00361.x
- Ireland JL, Wylie CE, Collins SN, Verheyen KLP, Newton JR (2013) Preventive health care and owner-reported disease prevalence of horses and ponies in Great Britain. *Research in Veterinary Science* 95, 418–424. doi:10.1016/j.rvsc.2013.05.007
- Johnstone LK, Mayhew IG (2013) Flow-mediated K+ secretion in horses intoxicated with lolitrem B (perennial ryegrass staggers). *New Zealand Veterinary Journal* 61, 159–164. doi:10.1080/00480169.2012.731682
- Jones K (2011) Kaimanawa Heritage Horses. Available at <https://kaimanawaheritagehorses.org/2011/07/16/site-welcome/#more-602> [accessed 2022]
- Jones B, Goodfellow J, Yeates J, McGreevy P (2015) A critical analysis of the British Horseracing Authority's review of the use of the Whip in Horseracing. *Animals* 5, 138–150. doi:10.3390/ani5010138
- Kaplan RM (2002) Anthelmintic resistance in nematodes of horses. *Veterinary Research* 33, 491–507. doi:10.1051/vetres:2002035
- Kaplan RM (2004) Drug resistance in nematodes of veterinary importance: a status report. *Trends in Parasitology* 20, 477–481. doi:10.1016/j.pt.2004.08.001
- Landman MAAM, de Blaauw JA, van Weeren PR, Hofland LJ (2004) Field study of the prevalence of lameness in horses with back problems. *Veterinary Record* 155, 165–168. doi:10.1136/vr.155.6.165
- Latch GCM, Christensen MJ, Samuels GJ (1984) Five endophytes of *Lolium* and *Festuca* in New Zealand. *Mycotaxon* 20, 535–550.
- Leadon DP, O'Toole D, Duggan VE (2012) A demographic survey of unwanted horses in Ireland 2005–2010. *Irish Veterinary Journal* 65, 3. doi:10.1186/2046-0481-65-3
- Legg KA, Breheny M, Gee EK, Rogers CW (2019) Responding to risk: regulation or prohibition? New Zealand media reporting of Thoroughbred jumps racing 2016–2018. *Animals* 9, 276. doi:10.3390/ani9050276
- Legg KA, Gee EK, Cochran DJ, Rogers CW (2021) Preliminary examination of the biological and industry constraints on the structure and pattern of thoroughbred racing in New Zealand over thirteen

- seasons: 2005/06–2017/18. *Animals* **11**, 2807. doi:10.3390/ani11102807
- Linklater WL, Cameron EZ, Stafford KJ, Veltman CJ (2000) Social and spatial structure and range use by Kaimanawa wild horses (*Equus caballus*: Equidae). *New Zealand Journal of Ecology* **24**, 139–152.
- Littlewood K, Beausoleil N, Stafford K, Stephens C (2021) 'What Would You Do?': How Cat Owners Make End-of-Life Decisions and Implications for Veterinary–Client Interactions. *Animals* **11**(4), 1114. doi:10.3390/ani11041114
- Lloyd S, Smith J, Connan RM, Hatcher MA, Hedges TR, Humphrey DJ, Jones AC (2000) Parasite control methods used by horse owners: factors predisposing to the development of anthelmintic resistance in nematodes. *Veterinary Record* **146**, 487–492. doi:10.1136/vr.146.17.487
- Longland AC, Barfoot C, Harris PA (2016) Effects of grazing muzzles on intakes of dry matter and water-soluble carbohydrates by ponies grazing spring, summer, and autumn swards, as well as autumn swards of different heights. *Journal of Equine Veterinary Science* **40**, 26–33. doi:10.1016/j.jevs.2015.09.009
- Lönnell C (2012) Yard differences in training, management and orthopedic injury in showjumping, riding school, and thoroughbred race horses. PhD thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.
- Lönnell C, Roepstorff L, Egenvall A (2012) Variation in equine management factors between riding schools with high vs. low insurance claims for orthopaedic injury. *The Veterinary Journal* **193**, 109–113. doi:10.1016/j.tvjl.2011.11.003
- Marshall J (2008) Whipping is horse racing's sore point. Available at www.HorseTalk.co.nz [accessed 2020]
- Martig S, Chen W, Lee PVS, Whitton RC (2014) Bone fatigue and its implications for injuries in racehorses. *Equine Veterinary Journal* **46**, 408–415. doi:10.1111/evj.12241
- McGowan C (2011) Welfare of Aged Horses. *Animals* **1**(4), 366–376. doi:10.3390/ani1040366
- McGowan CM, Ireland JL (2016) Welfare, quality of life, and euthanasia of aged horses. *Veterinary Clinics of North America: Equine Practice* **32**, 355–367. doi:10.1016/j.cveq.2016.04.011
- McGowan CM, Stubbs NC, Jull GA (2007) Equine physiotherapy: a comparative view of the science underlying the profession. *Equine Veterinary Journal* **39**, 90–94. doi:10.2746/042516407X163245
- McGowan TW, Pinchbeck G, Phillips CJC, Perkins N, Hodgson DR, McGowan CM (2010) A survey of aged horses in Queensland, Australia. Part 2: clinical signs and owners' perceptions of health and welfare. *Australian Veterinary Journal* **88**, 465–471. doi:10.1111/j.1751-0813.2010.00638.x
- McGreevy PD (1997) Do stabled horses cope? *Journal of Biological Education* **31**, 207–211. doi:10.1080/00219266.1997.9655564
- McGreevy P, French N, Nicol C (1995a) The prevalence of abnormal behaviours in dressage, eventing and endurance horses in relation to stabling. *Veterinary Record* **137**, 36–37. doi:10.1136/vr.137.2.36
- McGreevy PD, Cripps PJ, French NP, Green LE, Nicol CJ (1995b) Management factors associated with stereotypic and redirected behaviour in the Thoroughbred horse. *Equine Veterinary Journal* **27**, 86–91. doi:10.1111/j.2042-3306.1995.tb03041.x
- Mellor DJ, Beausoleil NJ (2015) Extending the 'Five Domains' model for animal welfare assessment to incorporate positive welfare states. *Animal Welfare* **24**, 241–253. doi:10.7120/09627286.24.3.241
- Mellor DJ, Burns M (2020) Using the five domains model to develop welfare assessment guidelines for Thoroughbred horses in New Zealand. *New Zealand Veterinary Journal* **68**, 150–156. doi:10.1080/00480169.2020.1715900
- Meredith K, Bolwell CF, Rogers CW, Gee EK (2011) The use of allied health therapies on competition horses in the North Island of New Zealand. *New Zealand Veterinary Journal* **59**, 123–127. doi:10.1080/00480169.2011.562861
- Ministry of Agriculture and Forestry (2011) What New Zealanders Really Think about Animal Welfare, MAF Technical Paper No: 2011/55, at 4.5.1. New Zealand Government, Wellington, New Zealand.
- Ministry of Primary Industries (2016) Livestock slaughter statistics. New Zealand Government, Wellington, New Zealand. Available at <https://catalogue.data.govt.nz/dataset/livestock-slaughter-statistics> [accessed 2022]
- Morrice-West AV, Hitchens PL, Walmsley EA, Stevenson MA, Whitton RC (2020) Training practices, speed and distances undertaken by Thoroughbred racehorses in Victoria, Australia. *Equine Veterinary Journal* **52**, 273–280. doi:10.1111/evj.13156
- Murray RC, Walters JM, Snart H, Dyson SJ, Parkin TDH (2010) Identification of risk factors for lameness in dressage horses. *The Veterinary Journal* **184**, 27–36. doi:10.1016/j.tvjl.2009.03.020
- New Zealand Government (2018) Code of welfare for horses and donkeys. Ministry for Primary Industries (Manatū Ahu Matua), Wellington, New Zealand. Available at <https://www.mpi.govt.nz/dmsdocument/46060-Code-of-Welfare-Horses-and-donkeys> [accessed 2022]
- New Zealand Government (2022) Animal Welfare Act 1999. Ministry of Primary industries (Manatū Ahu Matua), Wellington, New Zealand. Available at <https://www.legislation.govt.nz/act/public/1999/0142/latest/DLM49664.html> [accessed 2022]
- New Zealand Thoroughbred Racing (2021) Rules of Racing. New Zealand Thoroughbred Racing Inc., New Zealand. Available at <https://loveracing.nz/nztr/resources/rules-directives-and-policies> [accessed Feb 2022]
- Nicol C (1999) Understanding equine stereotypies. *Equine Veterinary Journal. Supplement* **28**, 20–25. doi:10.1111/j.2042-3306.1999.tb05151.x
- Nielsen MK (2009) Restrictions of anthelmintic usage: perspectives and potential consequences. *Parasites and Vectors* **2**(Suppl. 2), S7. doi:10.1186/1756-3305-2-S2-S7
- Nunamaker DM, Butterweck DM, Provost MT (1990) Fatigue fractures in thoroughbred racehorses: relationships with age, peak bone strain, and training. *Journal of Orthopaedic Research* **8**, 604–611. doi:10.1002/jor.1100080417
- NZPCA (2015) General Regulations. New Zealand Pony Clubs Association Incorporated, New Zealand. Available at <http://www.nzpca.org/asset/downloadasset?id=7aeaf72d-2629-47c2-aeb9-60f408d6f106> [accessed October 2022]
- Parker M, Goodwin D, Redhead ES (2008) Survey of breeders' management of horses in Europe, North America and Australia: comparison of factors associated with the development of abnormal behaviour. *Applied Animal Behaviour Science* **114**, 206–215. doi:10.1016/j.applanim.2008.02.003
- Pell SM, McGreevy PD (1999) Prevalence of stereotypic and other problem behaviours in thoroughbred horses. *Australian Veterinary Journal* **77**, 678–679. doi:10.1111/j.1751-0813.1999.tb13166.x
- Perkins NR, Reid SWJ, Morris RS (2005) Profiling the New Zealand Thoroughbred racing industry. 2. Conditions interfering with training and racing. *New Zealand Veterinary Journal* **53**, 69–76. doi:10.1080/00480169.2005.36471
- Racing Australia (2022) Australian rules of racing. Available at https://www.racingaustralia.horse/uploading/Australian_rules_of_Racing/Australian_Rules_of_Racing_06_May_2022.pdf [accessed October 2022]
- Reid K, Rogers CW, Gronqvist G, Gee EK, Bolwell CF (2017) Anxiety and pain in horses measured by heart rate variability and behavior. *Journal of Veterinary Behavior* **22**, 1–6. doi:10.1016/j.jveb.2017.09.002
- Robin CA, Ireland JL, Wylie CE, Collins SN, Verheyen KLP, Newton JR (2015) Prevalence of and risk factors for equine obesity in Great Britain based on owner-reported body condition scores. *Equine Veterinary Journal* **47**, 196–201. doi:10.1111/evj.12275
- Rogers GM (1991) Kaimanawa feral horses and their environmental impacts. *New Zealand Journal of Ecology* **15**, 49–64.
- Rogers CW, Cogger N (2010) A cross sectional survey of biosecurity practices on New Zealand Thoroughbred stud farms in New Zealand. *New Zealand Veterinary Journal* **58**, 64–68. doi:10.1080/00480169.2010.65087
- Rogers CW, Dittmer KE (2019) Does Juvenile play programme the equine musculoskeletal system? *Animals* **9**, 646. doi:10.3390/ani9090646
- Rogers CW, Firth EC (2005) Preliminary examination of the New Zealand event horse production system. *Proceedings of the New Zealand Society of Animal Production* **65**, 372–377.
- Rogers CW, Vallance A (2009) 'Studbook Application for Membership of the World Breeding Federation for Sport Horses.' (New Zealand Sport Horse Promotion Board Inc: Masterton, New Zealand)
- Rogers CW, Gee EK, Faram TL (2004a) The effect of two different weaning procedures on the growth of pasture-reared thoroughbred foals in New Zealand. *New Zealand Veterinary Journal* **52**, 401–403. doi:10.1080/00480169.2004.36458

- Rogers CW, Gee EK, Faram TL (2004b) The effect of two different weaning procedures on the growth of pasture-reared Thoroughbred foals in New Zealand. *New Zealand Veterinary Journal* 52, 401–403. doi:10.1080/00480169.2004.36458
- Rogers CW, Gee EK, Firth EC (2007a) A cross-sectional survey of Thoroughbred stud farm management in the North Island of New Zealand. *New Zealand Veterinary Journal* 55, 302–307. doi:10.1080/00480169.2007.36785
- Rogers CW, Rivero JLL, van Breda E, Lindner A, Sloet van Oldruitenborgh-Oosterbaan MM (2007b) Describing workload and scientific information on conditioning horses. *Equine Comparative and Exercise Physiology* 4, 1–6. doi:10.1017/S1478061507727408
- Rogers CW, Bolwell CF, Gee EK (2012a) Proactive management of the equine athlete. *Animals* 2, 640–655. doi:10.3390/ani2040640
- Rogers CW, Bolwell CF, Tanner JC, van Weeren PR (2012b) Early exercise in the horse. *Journal of Veterinary Behavior* 7, 375–379. doi:10.1016/j.jveb.2012.01.003
- Rogers CW, Bolwell CF, Gee EK, Peterson ML, McIlwraith CW (2014) Profile and surface conditions of New Zealand Thoroughbred racetracks. *Journal of Equine Veterinary Science* 34, 1105–1109. doi:10.1016/j.jevs.2014.06.017
- Rogers CW, Gee EK, Bolwell CF (2016) Horse production. In 'Livestock Production in New Zealand'. (Ed. K Stafford). (Massey University Press: Palmerston North, New Zealand)
- Rogers CW, Gee EK, Back PJ (2017a) Pastures and supplements in New Zealand commercial equine production systems. In 'Pasture and supplements for grazing animals.' (Eds PV Pratray, IM Brookes, AM Nicol). Occasional Publication 14. (New Zealand Society of Animal Production: Cambridge, New Zealand)
- Rogers CW, Gee EK, Bolwell CF, Rosanowski SM (2017b) Commercial equine production in New Zealand 2: Growth and development of the equine athlete. *Animal Production Science* 60, 2155–2163. doi:10.1071/AN16752
- Rogers CW, Bolwell CF, Gee EK, Rosanowski SM (2020) Equine musculoskeletal development and performance: impact of the production system and early training. *Animal Production Science* 60, 2069–2079. doi:10.1071/AN17685
- Rosanowski SM, Rogers CW, Cogger N, Benschop J, Stevenson MA (2012a) The implementation of biosecurity practices and visitor protocols on non-commercial horse properties in New Zealand. *Preventive Veterinary Medicine* 107, 85–94. doi:10.1016/j.prevetmed.2012.05.001
- Rosanowski SM, Cogger N, Rogers CW, Benschop J, Stevenson MA (2012b) A description of the demographic characteristics of the New Zealand non-commercial horse population with data collected using a generalised random-tessellation stratified sampling design. *Preventive Veterinary Medicine* 107, 242–252. doi:10.1016/j.prevetmed.2012.05.016
- Rosanowski SM, Cogger N, Rogers CW, Benschop J, Stevenson MA (2013) An investigation of the movement patterns and biosecurity practices on Thoroughbred and Standardbred stud farms in New Zealand. *Preventive Veterinary Medicine* 108, 178–187. doi:10.1016/j.prevetmed.2012.08.003
- Rosanowski SM, Rogers CW, Cogger N (2015) The movement pattern of horses around race meetings in New Zealand. *Animal Production Science* 55, 1075–1080. doi:10.1071/AN13345
- Rosanowski SM, Carpenter TE, Adamson D, Rogers CW, Pearce P, Burns M, Cogger N (2019) An economic analysis of a contingency model utilising vaccination for the control of equine influenza in a non-endemic country. *PLoS ONE* 14(1), e0210885. doi:10.1371/journal.pone.0210885
- Scantlebury CE, Archer DC, Proudman CJ, Pinchbeck GL (2015) Management and horse-level risk factors for recurrent colic in the UK general equine practice population. *Equine Veterinary Journal* 47, 202–206. doi:10.1111/evj.12276
- Scasta JD, Adams M, Gibbs R, Fleury B (2020) Free-ranging horse management in Australia, New Zealand and the United States: socio-ecological dimensions of a protracted environmental conflict. *The Rangeland Journal* 42, 27–43. doi:10.1071/RJ19019
- Shrestha K, Gilkerson JR, Stevenson MA, Flash ML (2021) Drivers of exit and outcomes for Thoroughbred racehorses participating in the 2017–2018 Australian racing season. *PLoS ONE* 16(9), e0257581. doi:10.1371/journal.pone.0257581
- Simmons HRG (2015) Investigation of current equine identification systems utilised in the New Zealand Equine industry. Masters Thesis. Massey University, Palmerston North, New Zealand.
- Smith P (2009) Stuff perception, whipping is cruel. Available at www.theaustralian.com.au/news/sport/stuff-perception-whipping-is-cruel/story-e6frg7uo-111119046038 [accessed 2022]
- Tanner JC, Rogers CW, Firth EC (2011) The relationship of training milestones with racing success in a population of Standardbred horses in New Zealand. *New Zealand Veterinary Journal* 59, 323–327. doi:10.1080/00480169.2011.617029
- Tanner JC, Rogers CW, Firth EC (2013) The association of 2-year-old training milestones with career length and racing success in a sample of Thoroughbred horses in New Zealand. *Equine Veterinary Journal* 45(1), 20–24. doi:10.1111/j.2042-3306.2011.00534.x
- Thompson K, McManus P, Stansall D, Wilson BJ, McGreevy PD (2020) Is Whip Use Important to Thoroughbred Racing Integrity? What Stewards' Reports Reveal about Fairness to Punters, Jockeys and Horses. *Animals* 10, 1985. doi:10.3390/ani10111985
- Thomson PC, Hayek AR, Jones B, Evans DL, McGreevy PD (2014) Number, causes and destinations of horses leaving the Australian Thoroughbred and Standardbred racing industries. *Australian Veterinary Journal* 92, 303–311. doi:10.1111/avj.12204
- Verhaar N, Rogers CW, Gee EK, Bolwell CF, Rosanowski SM (2014) The feeding practices and estimated workload in a cohort of New Zealand competition horses. *Journal of Equine Veterinary Science* 34, 1257–1262. doi:10.1016/j.jevs.2014.08.008
- Verheyen KLP, Henley WE, Price JS, Wood JLN (2005) Training-related factors associated with dorsometacarpal disease in young Thoroughbred racehorses in the UK. *Equine Veterinary Journal* 37, 442–448. doi:10.2746/042516405774480085
- Verheyen K, Price J, Lanyon L, Wood J (2006) Exercise distance and speed affect the risk of fracture in racehorses. *Bone* 39, 1322–1330. doi:10.1016/j.bone.2006.05.025
- Waran NK, Clarke N, Farnworth MJ (2008) The effects of weaning on the domestic horse (*Equus caballus*). *Applied Animal Behaviour Science* 110, 42–57. doi:10.1016/j.applanim.2007.03.024
- West DM, Bruère AN, Ridler AL (2002) 'The sheep: health, disease and production.' (Foundation for Continuing Education of the New Zealand Veterinary Association: Palmerston North, New Zealand)
- Wilsher S, Allen WR, Wood JLN (2006) Factors associated with failure of Thoroughbred horses to train and race. *Equine Veterinary Journal* 38, 113–118. doi:10.2746/042516406776563305

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