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Abstract

Data on the feeding and management of racehorses and the practices perceived to benefit horses displaying signs of recurrent exertional rhabdomyolysis (RER) were collected via a cross-sectional face-to-face survey of 100 registered Thoroughbred and Standardbred trainers in New Zealand (n=1,771 horses). In addition to quantitative data on feeding practices, qualitative data on trainers' perceptions and motivations for the different feeding and management practices were also collected. Few trainers recognised that starch in the diet was associated with increased clinical signs of RER (26% of Standardbred and 13% of Thoroughbred trainers). One third of trainers (39% of SB and 34% of TB) stated that oats contributed to RER. Most trainers with RER horses (96% TB and 84% SB) provided a day off (day with no training) to these horses. Half of the trainers with RER horses (SB and TB) decreased concentrate feeds on days off for all horses and few trainers (12.5% SB and 8% TB) only decreased concentrate on days off if the horse displayed signs of RER. Most trainers had sought advice about RER management from a veterinarian or feed representative (63% SB and 78% TB). However, despite this, many of the responses indicated a lack of clarity on the feed and management factors that contribute to the risk of clinical signs of RER.

Keywords: horse; feeding; Thoroughbred; Standardbred; recurrent exertional rhabdomyolysis

Introduction

The Thoroughbred and Standardbred racing industries have long-standing reputations for feeding and management strategies that are based on traditional methods. This is further enforced by strong family ties and generational influences. While younger generations are becoming successful trainers, management strategies are strongly influenced by their predecessors and there is often little room for evolving feeding and management techniques that are in line with the latest research on equine health and performance.

Exertional rhabdomyolysis (ER) is the overarching term for the various disorders causing muscle pain and stiffness that are triggered by exercise (Harris & Rivero 2017) and is the most common equine myopathy (MacLeay et al. 1999b) that affects most athletic breeds (Harris & Rivero 2017). Chronic and recurrent exertional rhabdomyolysis (RER) represent a syndrome of repeated exercise-associated muscle damage (McKenzie & Firshman 2009) accompanied by increased muscle enzyme activity, often with mild exertion at lower training intensity levels below the anaerobic threshold (Valberg 2005). While each type of exertional rhabdomyolysis has been known to occur in a variety of different breeds (Valberg 2010; Harris & Rivero 2017), there is potential economic loss to the racing industries with a high prevalence of RER (5-10%) reported in Thoroughbreds (MacLeay et al. 1999a,b).

The late nineties saw a surge in research focussing on enhancing performance, improving equine health, and reducing the risk of performance associated conditions such as RER. Research in these areas has continued in recent years, and knowledge around techniques to improve RER is constantly evolving. Previous associations with muscle calcium regulation abnormalities in the occurrence of RER (Lentz et al. 1999) have since been questioned (Piercy & Rivero 2014; Mickelson & Valberg 2015; Harris & Rivero 2017) and more recent work has shown the condition has a strong genetic component (Valberg 2006; Mickelson & Valberg 2015; Harris & Rivero 2017).

This research indicates that causes of RER are multi-factorial and management requires attention to both diet and exercise components. Changes in exercise management are thought to improve symptoms of the condition by moderating behaviour and/or excitability (Harris & Rivero 2017). Regular daily exercise is important in managing the condition and it is recommended that days off are minimised (Valberg 2010). Dietary management has been shown to mitigate symptoms, as diets with too-little fibre combined with too-much non-structural carbohydrates contribute to RER. Daily energy-source manipulation has been successful, with the current dietary recommendations being to limit starch sources to less than 20% of daily energy and include at least 20% of energy requirements as fat for horses in intense work (McKenzie & Firshman 2009; Valberg 2010; Harris & Rivero 2017).

Although there is research-based consensus on the treatment of RER, the traditional nature of the Thoroughbred and Standardbred racing industries means that management and feeding practices are not synchronised with research. Recent research has shown that current New Zealand feeding practices for RER horses are not in alignment with current recommendations. The average concentrate-

to-roughage ratios in Thoroughbreds and Standardbreds were found to be 5.6±0.15:4.8±0.2 and 4.12±0.16:3.46±0.2 respectively (Wood et al. 2019). The average starch levels as a percentage of total DE offered to horses displaying signs of RER in New Zealand was 33.4±1.1%. Only 7% (11/149) of horses displaying signs of RER were provided with dietary starch levels at the current best-management practice level of < 20% of total DE (Wood et al. 2019). Despite the availability of information around correct feeding practices for RER horses, these practices are not currently being applied in the Thoroughbred and Standardbred industries.

Despite an estimated RER prevalence of 8.4% (Wood et al. 2019), and ongoing research regarding risk factors and appropriate management of horses with RER, industry knowledge and the application of correct feeding and management factors in New Zealand appears limited. Information about current best practice for management of RER affected horses is readily available through qualified veterinarians and nutritionists. However, the data on current feeding practices displays a disconnect between this information and how it is disseminated to trainers (Wood et al. 2019). To remedy this situation, there is a need to examine why there is a gap between established veterinary guidelines and management practices. Further, improving management requires identifying whether the gap arises from the ways the information is delivered to trainers, or if traditional practices limit implementation of the best practice. To understand the driving factors behind feeding and management factors of horses with RER in New Zealand, this study reports on a cross-sectional survey of New Zealand Thoroughbred and Standardbred trainers and examines the rationale behind their selective feeding practices.

Materials and methods

The sample frame consisted of a convenience sample of registered Thoroughbred and Standardbred racehorse trainers with at least one horse currently in full race work. The trainers were selected from the major training tracks throughout the North and the South Islands. Trainers were initially selected through direct contact. Further trainers were then recruited at the same training venue, or area, using a snowball sampling technique beginning with a referral from the initial trainer contacted. This process was repeated until 100 trainers were recruited.

The survey was developed using a number of iterations and tested using racing industry personnel (none of which were included in the subsequent survey). The survey was then pilot tested on one trainer with < 10 horses and one trainer with > 20 horses in-work.

Prior to recruitment, the trainers were provided with a one-page summary and overview of the study. The symptoms of the condition (RER) were described in detail by the interviewer to each trainer. If they were not aware of "tying up" and how to identify the symptoms, they were excluded from the study (n=0 trainers). The survey consisted of a section of closed questions followed by a section of open questions. Initially trainers were asked for demographic data on the number of horses in work and the proportion of horses trained that were showing symptoms of RER, before asking for details of diets for horses that were displaying symptoms of RER and horses that were not. This first section contained quantitative questions relating to the current diets and management factors of horses that were and weren't displaying symptoms of RER. The trainers provided a description of the supplementary feed offered to the horses, including brand and/or type of feed offered. All hay, fibre products and concentrate feeds offered in a daily diet for all horses were weighed and expressed as kilograms dry matter offered (Verhaar et al. 2014). Further questions were also asked relating to management, including size of the turnout area each horse had access to.

The second section of the survey consisted of two qualitative questions relating to why the trainer adopted the current feeding practices for the horses with RER, what they believed were the risk factors of the condition, and what measures they thought they should be taking to manage the condition nutritionally. Such questions included "What are the reasons behind your feeding and management practices for your horses with tying up symptoms?" and "How do you believe horses showing symptoms of tying up should be fed and managed?" These questions would often prompt the trainer to continue discussing feeding practices, and lead into other topics of nutrition. As the trainer responded to these open-ended questions, the interviewer wrote notes describing the reasons given for current feeding and management practices. These responses were analysed thematically and coded to understand individual trainer knowledge and management reasoning further. Key words and phrases were used to code answers immediately following the completion of each survey. Where appropriate, differences in responses were examined using chi squared test and differences in means were tested using an ANOVA within Stata 12 (StataCorp LP, College Station, TX, USA).

Results

Data were collected via a cross-sectional face-to-face survey of 100 registered Thoroughbred and Standardbred trainers in New Zealand (n=1,771 horses; 995 Thoroughbreds and 776 Standardbreds). Detailed demographics of the respondents were published previously (Wood et al. 2019).

A consistent theme throughout both the answers to the closed and open-ended questions was a lack of clarity in identifying the major risk factors for clinical signs of RER. In some circumstances there was clear evidence of contradiction in these answers. For example, some trainers acknowledged the role of starch or grain levels as contributing to the risk of RER, whilst also reporting that they added grains to a commercial (low-starch) RER-specific pre-mixed ration.

There was widespread acknowledgement of the role

of diet in RER, with over half of the trainers (56%) making specific reference to starch and/or oats as contributing factors to the clinical symptoms of RER. However, when the analysis focused on the key nutritional component that elevates risk (the starch component of the ration offered), few trainers (19%) mentioned specifically that more starch in the diet was associated with greater risk of clinical signs of the condition. Of these trainers 32% (n=6) also mentioned that oats were associated with a greater risk of clinical signs of the condition. There was a trend for Standardbred trainers to be more likely to mention starch as a risk factor compared to Thoroughbred trainers (26% vs. 13%, p=0.07). However, this was found to be a relatively small proportion of the trainers surveyed.

Despite the moderate prevalence of RER in New Zealand racing stables, and the survey targeting trainers that were aware of the condition, the presence of RER horses in the stable did not alter the odds that the trainer would mention starch, or the relative levels of starch in the diet, and its relationship with clinical signs of RER.

Over one-third of all trainers (37%) specifically mentioned that oats were associated with increased risk of clinical signs of RER, with no difference in responses between Standardbred and Thoroughbred trainers (39% vs. 34%). Only six of these trainers also mentioned starch as a contributing factor towards symptoms of the condition.

Few of the trainers (n= 11) specifically mentioned both starch and oats as being contributing factors to the clinical symptoms of RER.

RER trainers

Most trainers reported they had horses in their stables displaying signs of RER (62/100). In this subset of trainers, 48% (30/62) made specific reference to starch and/or oats as contributing factors to the clinical symptoms of the condition. Over a third of trainers with RER horses specifically mentioned that oats were associated with increased risk of clinical signs of RER (37%; 23/62) but few (13%, n=3) also mentioned that starch was associated with increased risk of clinical signs of the condition. Many (66%) of the trainers of RER horses that identified both starch and oats as contributing to the symptoms of the condition decreased the quantity of concentrate fed to the RER horses on their day off work. One trainer specifically mentioned both oats and starch as increasing the risk of the condition but did not decrease the amount of concentrate feed provided to RER horses on days off. There was no association between mentioning starch or oats and providing a day off for the horses in training. This lack of association indicated that trainers with a more robust nutritional understanding did not complement this with knowledge of recent research-based training strategies for horses at risk of RER.

Most trainers with RER horses provided a day off (no training) to these horses (96% TB and 84% SB). None of the Standardbred trainers kept their RER horses in stables at all times and most (67%) gave them daily turnout in paddocks that were ≥ 0.1 ha. Fewer Thoroughbred trainers provided daily turnout in paddocks ≥ 0.1 ha (49%), and 11% kept their horses with RER symptoms in stables at all times. Average turn-out time given to RER horses was longer than that for non-RER horses for both breeds, with Thoroughbred trainers allowing an average of 13.1 hours per day and Standardbred trainers allowing 15.7 hours per day.

Most trainers had a standardised turnout time for all horses with only 23% providing their horses showing symptoms of RER more time in the paddock than their non-RER horses. Standardbred horses were provided more turnout time than were Thoroughbreds and, if additional turnout was provided for RER horses, they had an additional three hours turnout per day. Most trainers (80%) perceived that there was no benefit of swimming to reduce clinical signs of RER. There was a significant breed bias in this perception, with fewer Standardbred trainers with RER horses reporting any perception of benefit than did Thoroughbred trainers (6% vs. 24% , $P<0.05$).

Seeking advice about RER management was high, with 63% and 78% of Standardbred and Thoroughbred trainers respectively having sought advice on RER from a veterinarian, feed representative or both. Whether trainers had sought advice regarding management of RER or not did not alter the odds of that trainer mentioning that either oats or starch were contributing factors to the clinical signs of RER.

Discussion

The sample of trainers in this study is believed to be representative of the Thoroughbred and Standardbred racehorse trainer population in New Zealand, as sampling was distributed throughout New Zealand and the distribution of training-establishment size reflected published data on both the Thoroughbred and Standardbred racing industries (Legg et al. 2020; Bolwell et al. 2017). The even split of Thoroughbred (54) and Standardbred (47) trainers, and the even split of small (42) and large (58) trainers ensured a fair representation of training and management practices in both industries (Wood et al. 2019).

Despite various grains including barley, maize and oats provided in the diets of racehorses in New Zealand (Wood et al. 2019), approximately one third of trainers specifically mentioned oats as a contributing factor to the RER condition. However, few of these trainers mentioned excess dietary starch as a contributing factor. The assumption was that these trainers were not making the association that the primary energy source in oats is starch, and thus, by increasing the quantity of oats, they are increasing the percentage of DE that was derived from starch. This assumption is supported by the observation that few trainers specifically mentioned that increased dietary starch was associated with increased risk of clinical signs of RER, and six of these trainers were feeding oats to horses that were displaying clinical signs of RER. Despite maize being higher in starch than are oats, none of the

trainers mentioned maize as a contributing factor and oats were the only grain specifically mentioned.

This disassociation between grains and starch as the energy could be occurring through a lack of basic nutritional knowledge (understanding that oats contain starch), or through a disconnect between what the trainers know and what they are applying in everyday feeding practices. There may still exist a common misconception that racehorses can only obtain the DE required by the feeding of cereal grain-based concentrates. Recent work from Sweden has demonstrated that Standardbreds, in race training, can obtain sufficient DE from a predominantly forage / fibre-based diet and that this diet was not associated with any decrease in race performance (Ringmark et al. 2017). This finding is interesting ,as many of the Standardbred trainers that fed a low-starch diet designed for horses with clinical signs of RER added oats or barley to the diet. These cereals were added due to the belief this was necessary to provide sufficient DE to meet the demands of race training and racing. Such a practice shows a disconnect with current best practice and, that there may be significant latency in the dissemination of recent research findings within this group, despite the fact that the majority of trainers had sought advice from either a veterinarian or nutritionist. Translating research findings into daily practice can be problematic across disciplines and industries. Further research to examine in more detail the daily decision-making of trainers will enable greater understanding of the role of tradition and entrenched practice in preventing the uptake of evidence-based advice.

Management of RER and minimising clinical signs requires a multifactorial management and feeding approach. Energy requirements must be balanced with the workload and while days off (days when not worked) are not advised, if given there has to be a reduction in the DE supplied, but also the opportunity for free movement on those days off. Despite that fact that many trainers added a cereal grain to the pre-mixed low-starch RER diets, most trainers with RER horses indicated but they reduced the total volume of concentrates offered to RER horses on days off. Unfortunately, the methodology by which the data were collected did not permit us to identify if this reduction in concentrates offered included both the cereal and the specialist low-starch pre-mix, or just the cereal component of the diet. This type of data should be collected prospectively in association with management practices and documentation of the clinical signs of RER to provide greater clarity on the interaction of feed, management and exercise on RER under typical New Zealand conditions.

An interesting trend within the data was a reduction in the number of trainers keeping horses in stables $\geq$ 12 hours per day compared to an earlier cross-sectional survey (67% vs. 97% Williamson et al. 2007), particularly in Standardbred trainers who provided more turnout in general than Thoroughbred trainers. We were unable to identify the primary reason for this change in management practice. However, we hypothesised that this increased opportunity for exercise may be associated with an increased awareness by trainers of the benefits of free exercise. Reduced time in stables has been demonstrated to reduce the prevalence of stereotypical behaviours (Waters et al. 2010) which in some management systems, can have a high prevalence. While not detrimental to race training or success, stereotypical behaviours can be an indicator that horses are under some degree of stress and not in a positive affective state, and thus, often perceived negatively by industry participants. The limited differentiation of time outside between RER and non-RER horses may simply be a reflection of the difficulty in providing highly individualised management programmes for different horses, given the number of horses and number of different staff involved in their care and management. Greater consistency in management may be made possible by having a standardised time in turn out. Horses are social animals and become stressed when unable to see or touch co-specifics. Given that one of the major precursors for the expression of RER appears to be stress, it may be more efficient to have all horses with the same turnout time and reduce the chance of a horse becoming stressed if in the turnout yards for a longer period of time, but without co-specifics.

Maintenance of exercise load is important in reducing the clinical signs of RER, yet most trainers did not perceive any benefit from using swimming as an alternative exercise in the management of RER horses. This is in line with the cautious observation of Valberg et al. (2006) that swimming should be evaluated and utilised on an individual basis with RER horses, as it can exacerbate the condition. This limited perception of benefit from swimming may also be related to the limited routine use of swimming and access to swimming facilities (Steele et al. 2019).

Despite the availability of current research and professionals willing to assist trainers, there appears to be a struggle to transfer knowledge in the racing industry. The strong traditional ties mean trainers may choose to respect the knowledge of fellow successful trainers or previous trainers in their family rather than that of industry professionals. A probable mechanism for this would be through consistent exposure to other trainers at the track each morning. Seeing fellow trainers each morning but veterinarians or feed professionals only every week, or month, could have an impact on knowledge transfer and retention of information. Veterinarians are usually only utilised in a reactive manner, when an injury or illness has occurred, and are, therefore, providing advice on a more reactive basis rather than in a role providing establishment of best management practices (Meredith et al. 2011). Advice from feed specialists may not be fully utilised due to the trainers questioning possible motives for increased sales. There is also a possibility that failure of trainers to understand and retain correct information from veterinarians and feed specialists is occurring due to poor transfer of information from the industry specialists, and information not explained in a way that trainers can understand.

Resistance to change and the slow uptake of recent research is not unique to the racing industry. Poor information transfer and repeated exposure to fellow trainers are contributing factors, and there are indications of tradition limiting implementation of best practice. However, there is a real need to generate a culture of a proactive management approach to the equine athlete (Meredith et al. 2011). The use of specialist lower-starch feeds is encouraging, but the addition of cereals indicates some limitations in the knowledge of equine nutrition, requiring a greater focus from industry consultants on, not just providing an option to minimise risk (such as low-starch feeds), but on education of the underlying nutrition principles and the benefits they have in managing this condition.

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