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Review Article

The Ridden Horse Pain Ethogram

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Summary

The Ridden Horse Pain Ethogram (RHpE) comprises 24 behaviours, the majority of which are at least 10 times more likely to be seen in lame horses compared with non-lame horses. The observation of ≥8/24 behaviours is likely to reflect the presence of musculoskeletal pain, although some lame horses score <8/24 behaviours. A marked reduction in RHpE scores after resolution of lameness using diagnostic anaesthesia proves a causal relationship between pain and RHpE scores. Horses should be assessed for approximately 10 min in walk, trot (including 10 m diameter circles), canter and transitions. The validity of the RHpE has been verified for use in horses which perform dressage-type movements, and which have been trained to work with the front of the head in a vertical position. It has not, as yet, been used in horses while jumping, racehorses, western performance or endurance horses. The RHpE provides a valuable tool for riders, trainers, veterinarians and other equine professionals to recognise the presence of musculoskeletal pain, even if overt lameness cannot be recognised. Riders with a higher skill-level may improve gait quality, but cannot obscure behavioural signs of pain, although specific behaviours may change. Tight saddle tree points, the rider sitting on the caudal third of the saddle and rider weight may influence RHpE scores. Accurate application of the RHpE requires training and practice. The RHpE is a powerful tool for the assessment of ridden horses and the identification of likely musculoskeletal pain. Such pain merits further investigation and treatment, to improve equine welfare and performance. The RHpE provides an additional means of evaluating the response to diagnostic anaesthesia. It provides a mechanism for client education and a diplomatic way of communicating with clients about equine discomfort related to saddle-fit, rider size, their position in the saddle and ability to ride in balance.

This commissioned article reviews the development of the Ridden Horse Pain Ethogram (RHpE) and its validation. It describes how and when to use the RHpE and discusses the current evidence about factors other than musculoskeletal pain which may influence RHpE scores.

What is the Ridden Horse Pain Ethogram?

An ethogram is a catalogue of behaviours, each with strict definitions (Grier 1984). The RHpE comprises 24 behaviours, the majority of which are at least 10 times more likely to be seen in a lame horse compared with a non-lame horse (Dyson *et al*. 2018a). The presence of eight or more of these behaviours is likely to reflect the presence of musculoskeletal pain. Different horses react to musculoskeletal pain in a variety of ways, therefore the spectrum of behaviours demonstrated does not indicate the specific source(s) of pain, although pilot observations using principal component analysis suggest that clusters of behaviours may occur together (Dyson and Ellis 2020).

Why was the RHpE developed?

There is a high frequency of occurrence of lameness in the ridden sports horse population, which is apparently unrecognised by owners (Greve and Dyson 2014; Dyson and Greve 2016). Abnormalities of canter, for example close spatial and temporal placement of the hindlimbs or the lack of a suspension phase (Barstow and Dyson 2015; Boado *et al*. 2020; Greve and Dyson 2020), are frequently overlooked. There appears to be an ethos in the horse world for blaming ridden horse performance problems on the horse's behaviour, the rider's inadequacies, or faults in training, rather than considering that a problem may reflect musculoskeletal pain. From a welfare perspective, there was a clear need to provide a new tool to facilitate owner recognition of the presence of underlying discomfort. This problem is not unique to the horse and there is an increasing recognition in other species, such as the dog and cat, that alterations in behaviour are often a manifestation of pain (Mills *et al*. 2020).

The majority of veterinarians have received little training in the recognition of low-grade lameness, the ways in which ridden horses adapt to musculoskeletal pain (Greve and Dyson 2020), and the influence that discomfort can have on ridden horse performance. Some owners who do recognise that their horse may show signs of an underlying pain-related problem have faced frustration, because many veterinarians have shown a lack of ability to recognise ridden horse performance problems, or have received inadequate training for assessment of ridden horse problems. The potentially unnecessary expense of whole-body skeletal scintigraphy, which frequently provides misleading results (Quiney *et al*. 2018), the conclusion that a problem is solely behavioural, or the advice to 'ride him through it', creates distrust in the profession's ability to provide answers. The use of objective gait analysis in ridden horses remains in its infancy and measurement of gait asymmetry in hand does not necessarily translate to ridden horse performance. Moreover, a horse with either bilateral or multilimb lameness may show no obvious asymmetry (Buchner *et al*. 1995; Bragança *et al*. 2016; Greve *et al*. 2017). In addition, a subjectively non-lame horse, selected based on a comprehensive lameness examination, may exhibit gait asymmetry above the objective threshold defined for lameness (Greve and Dyson 2016). Thus, a tool

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which helps the recognition of pain in ridden horses would be a valuable addition to the veterinarian's diagnostic armamentarium.

How was the RHpE developed?

Preliminary investigation of ridden horse behaviour evaluated facial expressions (Mullard *et al*. 2017; Dyson *et al*. 2017, 2018c), because facial expressions had been proven to be important in pain recognition in the horse (Dalla Costa *et al*. 2014, 2016; Gleerup *et al*. 2015; Van Loon and Van Dierendonck 2015) and other species (Cheung and Choi 2008; Langford *et al*. 2010; Ahola Kohut *et al*. 2012; Descovich *et al*. 2017). It was demonstrated that lame and non-lame horses could be differentiated by evaluation of facial expressions alone (Dyson *et al*. 2017).

By examination of video recordings of ridden non-lame and lame horses an ethogram comprising 117 behaviours encompassing facial expressions, head position and movement, tail movements, body posture and responses to a rider's cues was developed (Dyson *et al*. 2018a). The ethogram was applied by an experienced assessor to video recordings of nine horses on two occasions and excellent repeatability was observed. By application of the 117 behaviours ethogram to lame and non-lame ridden horses, 24 behaviours were identified which were seen more often in lame horses, the majority of which were at least 10 times more likely to be seen in horses with musculoskeletal pain compared with non-lame horses. These 24 behaviours make up the RHpE (**Table 1**, **Figs 1–6**). The display of ≥8/24 behaviours was highly likely to reflect the presence of musculoskeletal pain, although some lame horses scored <8/24 behaviours. Most non-lame horses scored 0–4 (median 2), whereas the median score for lame horses was 9 (range 4–14).

Resolution of lameness by diagnostic anaesthesia resulted in significant reductions in the RHpE scores, consistently to <8/24, when the ethogram was applied by an experienced assessor (Dyson *et al*. 2018b; Dyson and Van Dijk 2020), or by untrained assessors of various professional backgrounds (Dyson and Van Dijk 2020). The latter study identified features of the ethogram which untrained assessors found more difficult to identify, for which training would be beneficial (for example, an intense stare [**Figs 1a**, **3a**, **4b**, **5b**], the bit being pulled through to one side [**Figs 1b**, **3a**]). In addition, a threshold of 6, 7, 8 or 9 behaviours for differentiation between non-lame and lame horses was tested, and 8/24 behaviours had the highest combined sensitivity (0.86) and specificity (0.80) compared with 6 (sensitivity 0.95, specificity 0.65), 7 (sensitivity 0.92, specificity 0.72) and 9 (sensitivity 0.81, specificity 0.80). The substantial reduction in RHpE scores after resolution of pain by diagnostic anaesthesia validated a causal relationship between pain and alterations in behaviour.

How has the RHpE been validated?

All the initial development and testing of the RHpE used video recordings. However, comparison between video assessment and real-time application of the RHpE showed excellent agreement for a trained assessor (Dyson *et al*. 2020b). The ability of a cross-section of equine veterinarians of variable age, sex and experience to apply the RHpE in real-time, after preliminary training, was tested by the evaluation of 20 horse-rider combinations performing a purpose-designed dressage test of 8.5 min' duration (Dyson *et al*. 2020b). The volunteer riders considered that their horses were capable of working comfortably, 'on the bit' at trot and canter for 30 min. The gait of the horses was assessed independently by another experienced equine clinician, who determined the presence of lameness and/or abnormalities of canter. By application of the RHpE alone, the trained veterinarians were able to differentiate horses with low-grade lameness (the most frequent lameness grade was 2/8 [Dyson 2011]) and abnormalities of canter and non-lame horses, with good agreement with an experienced assessor.

The RHpE was further tested by use in the field. Data from the 20 horses described in Dyson *et al*. (2020b) were combined with data from the evaluation of a convenience sample of a further 40 horses in regular work and presumed

TABLE 1: The Ridden Horse Pain Ethogram, adapted from Dyson *et al*. 2018a

1. Repeated changes of head position (up/down), not in rhythm with the trot
2. Head tilted or tilting repeatedly
3. Head in front of vertical (>30°) for ≥ 10 s
4. Head behind vertical (>10°) for ≥ 10 s
5. Head position changes regularly, tossed or twisted from side to side, corrected constantly
6. Ears rotated back behind vertical or flat (both or one only) ≥5 s; repeatedly lay flat
7. Eye lids closed or half closed for 2–5 s; frequent blinking
8. Sclera exposed repeatedly
9. Intense stare (glazed expression, 'zoned out') for ≥ 5 s
10. Mouth opening ± shutting repeatedly with separation of teeth, for ≥ 10 s
11. Tongue exposed, protruding or hanging out, and/or moving in and out repeatedly
12. Bit pulled through the mouth on one side (left or right), repeatedly
13. Tail clamped tightly to middle or held to one side
14. Tail swishing large movements: repeatedly up and down/ side to side/ circular; repeatedly during transitions
15. A rushed gait (frequency of trot steps > 40/15 s); irregular rhythm in trot or canter; repeated changes of speed in trot or canter
16. Gait too slow (frequency of trot steps < 35/15 s); passage-like trot
17. Hindlimbs do not follow tracks of forelimbs but repeatedly deviated to left or right; on 3 tracks in trot or canter
18. Canter repeated leg changes in front and/or behind; repeated strike off on wrong leg; disunited
19. Spontaneous changes of gait (e.g. breaks from canter to trot, or trot to canter)
20. Stumbles or trips more than once; repeated bilateral hindlimb toe drag
21. Sudden change of direction, against rider's cues; spooking
22. Reluctance to move forwards (has to be kicked ± verbal encouragement), stops spontaneously
23. Rearing (both forelimbs off the ground)
24. Bucking or kicking backwards (one or both hindlimbs)

Assessments are made in walk, trot (to include 10 m diameter circles in rising trot), canter and transitions on both the left and right reins, and in more advanced movements requiring collection in horses which are trained to do so. A total behaviour score of ≥8 (out of 24) is likely to indicate the presence of musculoskeletal pain. S, seconds

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***Fig 1:** a) Front of the head behind the vertical ≥10°, intense stare, ears upright and rotated outwards, but not behind vertical position. Mouth open with separation of the teeth. Tail swishing coinciding with the application of a spur cue. b) Front of the head behind the vertical ≥10°, mouth open with separation of the teeth, tongue out, bit pulled through to the right.*

***Fig 2:** Sequential photographs in trot. a) Head tilted, right ear back, right eyelids closed, front of head ≥30° in front of vertical position, tail swishing. b) Head tossing, front of head ≥30° in front of vertical position, both ears back, tail swishing. Mouth open exposing the teeth and gums, but teeth not separated, therefore does not fulfil RHpE criteria.*

***Fig 3:** a) Right ear back, intense stare, bit pulled through to the right, front of head ≥30° in front of vertical position. Abnormal elevation of the forehand in right canter. The rider complained that the horse 'hung' on the right rein; however, rein tension became much more symmetrical when hindlimb lameness and canter quality were improved using diagnostic anaesthesia. b) Head tilt with nose to right. Left ear back. Right ear rotated outwards. c) Tail swishing, front of the head behind the vertical ≥10°. Croup high in left canter; lack of suspension phase.*

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Fig 4: a) Spooking. b) Rearing, intense stare. c) Front of head ≥30° in front of vertical position in left canter; ears back, tail swishing. d) Front of head slightly behind vertical position but <10°, therefore does not fulfil RHpE criteria; mouth open with separation of the teeth. Croup high in left canter.

by their owners to be working comfortably (Dyson and Pollard 2020). The horses comprised Riding School horses, those used for General Purposes (including unaffiliated competition), Show Jumping, Eventing and Dressage, and performed the same purpose-designed dressage test. The RHpE was applied retrospectively to video recordings acquired in a standardised fashion. Overall, 73% of horses were lame (≤grade 2/8) on one or more limbs and 47% had gait abnormalities in canter. Ridden Horse Pain Ethogram scores ranged from 3–16/24 (median 9). The effect of breed, sex, horse age, work-discipline, epaxial muscle hypertonicity or pain (assessed by an equine physiotherapist), an ill-fitting saddle (evaluated by a Society of Master Saddlers Qualified Saddle Fitter), rider skill score (determined by a British Horse Society Instructor), and the presence of lameness or gait abnormalities in canter (assessed by an experienced equine clinician) on the RHpE score was assessed using Poisson regression. Two variables were retained in the final multivariable analysis, lameness ($P = 0.008$) and rider skill score as a continuous variable ($P<0.001$). A RHpE score ≥8/24 was again a good indicator of the presence of musculoskeletal pain.

In an additional study comprising a convenience sample of sports and leisure horses, gait in hand and when ridden were evaluated independently, by two veterinarians, and compared (Dyson *et al*. 2020c). Movement of the saddle during ridden exercise and rider position, balance and size relative to the saddle were documented by a British Horse Society Instructor. Ridden Horse Pain Ethogram scores were determined by a skilled assessor based on evaluation of video recordings. Multivariable Poisson regression analysis was used to determine factors which influenced the RHpE scores. Of 148 horses, 28% were lame in hand, whereas 62% were lame ridden. Sixty percent of horses showed gait abnormalities in canter. The median RHpE score was 8/24 (interquartile range 5, 9; range 0, 15). There was a significant positive association between lameness and the RHpE score. Riding School horses had higher RHpE scores compared with General Purpose horses. Saddles with tight tree points and riders seated at the back of the saddle rather than the middle were significantly associated with higher RHpE scores.

Overall, gait and RHpE data from 491 horses have been assessed and documented. These comprised non-lame

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Fig 5: a) On 3 tracks: the right hindlimb is following the left forelimb; the left hindlimb is to the left of the left forelimb. The tail is crooked, held to the right, coincident with the right hindlimb and left forelimb bearing weight in trot. b) Resistant to go forward. Intense stare, exposure of the sclera, head tilted, front of head ≥30^0 in front of vertical position, tail swishing.

Fig 6: a) Right hindlimb toe drag. Crooked tail with tail to left during the stance phase of the left hindlimb and right forelimb in trot. The saddle has slipped to the right. b) Front of the head behind the vertical ≥10°, despite no rein tension. c) Tail swishing, while performing shoulder-in. The saddle has slipped to the right.

horses, lame horses, and lame horses before and after diagnostic anaesthesia had been used to abolish pain causing lameness or abnormalities of canter (Dyson *et al*. 2018a,b; Dyson 2019; Dyson and van Dijk 2020; Dyson and Ellis 2020; Dyson and Pollard 2020; Thomson *et al*. 2020; 2020a; Dyson *et al*. 2020a, 2020c). These data provide strong evidence that the display of ≥8/24 behaviours of the RHpE is likely to reflect the presence of musculoskeletal pain, although some lame horses score <8/24. The validity of the RHpE has been verified for use in horses which perform dressage-type movements and which have been trained to work with the front of the head in a vertical position. It has not, as yet, been used in horses while jumping, racehorses, western performance horses or endurance horses. The data also illustrate the importance of evaluating horses ridden, to include transitions between and within gaits, trot, canter, 10 m diameter circles in rising trot, and more collected work for horses working at a more advanced level.

The results of application of the RHpE by 23 assessors have been documented, including skilled assessors (Dyson *et al*. 2018a,b; 2020c; Dyson and Ellis 2020; Dyson and Pollard 2020), equine veterinarians after preliminary training (Dyson *et al*. 2020b), an equine physiotherapist after on-line training[1] and additional repeatability assessment (Dyson *et al*. 2020d)

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and non-trained assessors from a variety of equine-related professions (Dyson and Van Dijk 2020).

How to use the RHpE

What you need to know before using the RHpE

The assessor needs to be fully aware of the definitions of each of the 24 behaviours (**Table 1**, **Figs 1–6**), and the use of a check sheet (**Supplementary Item 1**) is strongly advised. Certain factors need to be assessed before the RHpE is applied. Some arena surfaces are very deep, and all horses appear to disturb the footing with their hind feet, making it difficult to determine accurately if the horse has a bilateral hindlimb toe drag. If the bit is too wide, then the bit will appear that it is being pulled through to one or both sides of the horse's mouth. Some horses have a small iris in one or both eyes, so the sclera can be seen at rest, so repeated exposure of the sclera cannot be counted as a pain behaviour in one or both eyes of these horses. If the muzzle is pink (**Fig 6b**) it may make it more challenging to determine if the mouth is open.

Timing, work pattern, duration and intensity

After a short period of warm-up following the rider's usual protocol, the horse should be worked in walk, trot and canter on both reins around the periphery of the arena, and should be observed from both sides, the front and the rear (**Fig 1–6**). In a rectangular arena it is best to watch the horse from two different corners, on the left and right reins, respectively. It is important to view the horse from behind as well as from both sides and from the front on both reins. Ideally the horse should also be observed performing 10 m diameter circles in rising trot, to the left and right, as figures of eight. Some horses are completely comfortable being ridden in working paces and may only show discomfort when working in collection in specific movements. It is therefore important to observe the horse performing its full repertoire of movements. The horse should be observed for a minimum of 5 min and up to 10 min. Some of the behaviours are defined as being time dependent (for example, ears behind vertical for ≥5 s) and their duration should be timed using a stopwatch. An assessor has to be aware of how a rider is applying cues to the horse. For example, tail swishing may coincide with application of a spur aid (**Fig 1a**), rather than occurring spontaneously, and therefore should be disregarded unless repeated under other circumstances. It must be borne in mind that several of the definitions state 'repeated', for example repeated incorrect strike off into canter, repeated exposure of the sclera; a single occurrence of such a behaviour would not fulfil the criteria of the ethogram.

Training

As with any clinical skill, training and practice are essential for accurate interpretation of the RHpE and improvements in performance with training have been demonstrated (Mullard *et al*. 2017; Dyson *et al*. 2020b). An on-line training course is available[1], although the effectiveness of this training course has not been scientifically validated.

Factors that can potentially influence the RHpE

A RHpE score ≥8/24 is likely to reflect the presence of musculoskeletal pain, but to date no relationship between the RHpE score and the source(s) of pain has been determined. Rider size may also influence the RHpE score. In a cross-over design study, four riders of varying size rode six horses in randomised order, performing a standardised dressage-type test (Dyson *et al*. 2018d, 2020a). There was a significant positive correlation between rider weight and the RHpE score, although the majority of scores were <8/24.

Saddle fit for both the horse and the rider are potential influential factors on RHpE scores (Dyson *et al*. 2018d, 2020a). In a few small studies an ill-fitting saddle, considered by a Society of Master Saddlers Qualified Saddle Fitter to have the potential to adversely affect performance, did not have a statistical influence on RHpE scores (Dyson and Pollard 2020; Dyson *et al*. 2020b, 2020d). However, in a much larger scale study, saddles with tight tree points compared with correctly-fitted saddles and riders seated at the back of the saddle rather than the middle were associated with significantly higher RHpE scores (Dyson *et al*. 2020c). This is consistent with previous clinical observations that there have been dramatic improvements in RHpE scores and gait in some horses after change from a saddle with excessively tight tree points to a better fitting saddle (Dyson *et al*. 2020b). However, if an underlying lameness is also present, abnormal behaviour will persist.

Rider skill has the potential to influence the quality of a horse's gait. When the performance of 40 horses was assessed, each ridden by two different riders, a professional rider and the horse's usual rider, there was a significant correlation between rider skill scores and gait quality scores (Dyson *et al*. 2020d). The presence of lameness or gait abnormalities in canter, when ridden by each rider, varied among horses. However, there was no significant effect on the total RHpE scores when horses were ridden by their usual riders compared with the professional rider. Nonetheless, some individual behaviours did change. Thus, a more skilled rider may make a horse move better compared with a less skilled rider but will generally be unable to conceal behavioural signs of musculoskeletal pain, although the specific behaviours exhibited may change.

There is considerable controversy about the use of potentially restrictive nosebands (Fenner *et al*. 2016; Doherty *et al*. 2017; Uldahl and Clayton 2019) and the use of a bit as opposed to a bitless bridle (Cook and Kibler 2019; Mellor 2020). In a study of 148 ridden horses, those wearing crank cavesson nosebands compared with cavesson nosebands had significantly higher RHpE scores, but there was no effect of other noseband types (Dyson *et al*. 2020c). There was no difference in mouth opening, as defined by the RHpE (**Figs 1b**, **4d**), in horses with a noseband with the potential to restrict mouth opening, compared with a correctly-fitted cavesson noseband, or no noseband. In lame horses, diagnostic anaesthesia resulting in resolution of lameness was associated with substantial reductions in RHpE scores, despite the presence of a bit and potentially restrictive nosebands (Dyson *et al*. 2018b; Dyson and Van Dijk 2020). However, the proportional reduction in the frequency in occurrence of mouth opening with separation of the teeth for ≥10 s, was less than for some other behaviours (Dyson and Van Dijk 2020). Mouth opening with separation of the teeth for ≥10 s was commonly observed in horses warming up for the dressage phase of 5-star three-day events, the majority of which wore potentially restrictive nosebands (Dyson and Ellis 2020).

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We expect to observe substantial reduction in RHpE scores after abolition of pain using diagnostic anaesthesia, assuming that the saddle fits adequately (Dyson *et al*. 2018b; Dyson and Van Dijk 2020). However, in some horses the behaviour 'Front of head $\geq 30^0$ in front of vertical for $\geq$10 s' may change to 'Front of head $\geq 10^0$ behind vertical for $\geq$ 10 s' (Dyson and Van Dijk 2020). Factors influencing head and neck position in ridden horses are discussed elsewhere (Dyson *et al*. 2020d). A bilateral hindlimb toe drag may persist or develop after diagnostic anaesthesia of the hindlimbs. A crooked tail may persist despite improvement in gait (Dyson and Van Dijk 2020; Hibbs *et al*. 2020). Crooked tail carriage was abolished in only 12% (20/164) horses in which hindlimb gait abnormalities were improved by diagnostic anaesthesia (Hibbs *et al*. 2020).

Other factors to consider when assessing ridden horses

There are a number of other factors which need to be considered when assessing ridden horses which were not assessed during the development of the RHpE because of variation in horse fitness, environmental conditions, the accuracy of audio recordings of horses and observations which cannot be quantified but can be communicated via the rider. These are subjective observations, but have been repeatable (Dyson *et al*. 2018b; Dyson and Van Dijk 2020), although the underlying cause may be multifactorial. The change in observations after resolution of underlying musculoskeletal pain using diagnostic anaesthesia lends credence to cause and effect. Sweating or a respiratory rate which are disproportionate to the work intensity, horse fitness and environmental temperature are likely indicators of musculoskeletal pain. There may be an increase in respiratory noise in movements or gaits which the horse finds biomechanically more demanding. Repeated teeth grinding usually reflects discomfort. There are aspects of behaviour and movement which require the assessor to communicate with the rider, for example horse tension and rideability (the horse's acceptance of, and responsiveness to, the rider's cues), the range of motion of the thoracolumbosacral region and the impulses generated through the rider's back, and the way in which the rider's pelvis is moved during canter (Dyson 2016a, 2017). Rein tension may be altered, with either lack of rein tension (**Fig 6b**), excessive rein tension (the horse 'hanging' on the rider's hands) or asymmetrical rein tension (the horse 'leaning' on one side of the bit, which is reflected by bit position in some horses [**Fig 3a**]). In association with hindlimb lameness the saddle may consistently slip to one side (Greve and Dyson 2013; 2014) (**Fig 6a,b**). Finally, snorting or nose blowing are often observed after improvement in lameness by diagnostic anaesthesia (Dyson *et al*. 2018b), presumably reflecting improved comfort and a positive emotional state (Stomp *et al*. 2018, 2020).

It must also be recognised that oral, ocular or visceral pain (for example equine gastric ulcer syndrome) can contribute to pain in ridden horses and result in alterations in behaviour (Kjærulff and Lindegaard 2020). However, it must also be borne in mind that gastric ulceration may develop secondary to chronic musculoskeletal pain and resolution of the ulcers may not improve ridden horse behaviour (Dyson *et al*. 2021).

When to use the RHpE

There are multiple potential uses for the RHpE. Many equine clinicians have faced the situation when an owner fails to recognise or refuses to acknowledge that their horse has a combination of problems, resulting in chronic musculoskeletal pain, for which there is a guarded prognosis for pain-free ridden exercise. The RHpE provides an additional means of communicating with, and educating, the owner. The RHpE also provides a diplomatic means of illustrating to an owner that there may be an unacceptable imbalance between horse and rider size, and can be used to demonstrate the effect of the rider's position in the saddle.

The RHpE enables owners, veterinarians and other paraprofessionals to recognise the presence of subclinical problems, which merit further investigation by a veterinarian skilled at the investigation of ridden horse problems. Early recognition of musculoskeletal pain and accurate diagnosis will facilitate effective long-term management and improve both performance and equine welfare.

At a pre-purchase examination the aim is to be a detective, to determine the risks involved with purchase of a horse for a specific purpose, for a specific rider. Any tool which gives additional information is of potential value. The RHpE has been routinely applied at pre-purchase examinations for several years (S. Dyson, unpublished data). There are circumstances when horses have been coping at their current work level, with their regular rider, and appear to move symmetrically, but do not move with normal fluidity, do not have normal range of motion of the thoracolumbosacral region and have restricted gaits. If the RHpE score is $\geq$ 8/24 this provides additional information that there is likely to be underlying musculoskeletal pain. Purchasers are advised accordingly of the potential risks. Horses purchased despite these discussions have been observed to subsequently deteriorate and require long-term management to maintain adequate comfort (S. Dyson, unpublished data).

The RHpE can be used to assess a horse's response to the fit of a saddle for both the horse and the rider. An association between both tight saddle tree points and the rider sitting on the caudal one-third of the saddle and the RHpE score has been documented (Dyson *et al*. 2020c). Skilled saddle-fitters have long-recognised a relationship between saddle-fit and equine behaviour (Schleese 2014).

When investigating poor performance in ridden horses the use of diagnostic anaesthesia is crucial for identifying the source(s) of pain (Dyson 2016b). The response to diagnostic anaesthesia can be evaluated by the presence or absence of lameness, the quality of the horse's gaits and the horse's behaviour. If there is not substantial reduction in the RHpE score it implies that there is residual pain, requiring further investigation. When differentiating trigeminal-mediated head shaking behaviour with head tossing behaviour in ridden horses, secondary to musculoskeletal pain, the RHpE can be used to support the likely presence of musculoskeletal pain (Thomson *et al*. 2020). The RHpE score has provided evidence that idiopathic hopping-type forelimb lameness in ridden horses (Dyson and Rasotto 2016) is likely to be pain-induced (Dyson 2020). This is despite no response to systemically administered analgesic medication, and no change or deterioration in lameness following diagnostic anaesthesia, possibly because the lameness is associated with neuropathic pain (Dyson 2020).

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The power of the RHpE has been demonstrated by its application to horses during warm-up for the dressage phase at 5-star three-day events (Dyson 2019; Dyson and Ellis 2020). There was a significant positive correlation between dressage penalty scores and the RHpE score. Fifty-nine percent of horses with a RHpE score ≥7 failed to complete cross-country, compared with 33% with a score <7 (Dyson and Ellis 2020). Horses that failed to complete the cross-country phase had significantly higher RHpE scores compared with those that completed. There was a significant relationship between total RHpE score and final horse placings, with higher scores being associated with lower placings. Horses with lameness or gait abnormalities in canter had significantly higher RHpE scores compared with other horses. It was concluded that the RHpE should facilitate earlier identification of horses competing at 5-star three-day events which may benefit from diagnosis and treatment, resulting in improvement in both equine performance and welfare, and potentially also the safety of both the horse and the rider.

Conclusions

The RHpE is a powerful tool for the assessment of ridden horses and for the identification of likely musculoskeletal pain that merits further investigation and treatment, to improve equine welfare and performance. It provides an additional means of evaluating the response to diagnostic anaesthesia. It provides a mechanism for client education and a diplomatic way of communicating with clients about equine discomfort related to rider size, their position in the saddle and their ability to ride in balance.

Author's declarations of interest

No conflicts of interest have been declared.

Ethical animal research

Not applicable.

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Authorship

The review was the sole work of the author.

Manufacturer's address

[1]How to recognize the 24 behaviors indicating pain in the ridden horse. Equitopia. www.EquitopiaCenter.com

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1. A check sheet for practical day to day application of the Ridden Horse Pain Ethogram.

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