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Review Article ***Open Access***

Is the welfare of sport horses assured by modern management practices?

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SUMMARY

The aim of the article was to identify potential adverse circumstances in the breeding, keeping, training, and use of horses in sports, which could negatively impact their well-being. The review identified numerous consequences of errors in nutrition, housing, training and use, as well as exposure to stress, pain, injury, and disease. A significant number of sport horses are diagnosed with health disorders, including stomach ulcers, pain, injuries of the back and mouth, lameness, and stereotyped behaviour. This can significantly reduce the horse's quality of life. There is a need for more flexibility in the management of sport horses, including diet and supplementation, improved housing, selection of equipment, and riding aids, which will ensure horses' welfare. There is also a need to educate those involved in the horse industry. This should lead to real improvements in the level of well-being and comfort of sport horses.

KEY WORDS: welfare, equestrian sport, equine athlete, equine management, equine well-being

INTRODUCTION

According to the European Horse Network, about 20,000 equestrian sporting events take place yearly, with annual revenues from the industry estimated at 100 billion euros (europeanhorsenetwork.eu). Approximately 3,5 million horses are used in various equestrian sports in Europe. The United States equine industry as a whole generates approximately $122 billion in overall revenues, with the racing sector accounting for 42% and other horse competitions for slightly less. The horse population in the United States is estimated at 7,2 million (Economic contributes £8 billion a year to the economy (statista.com). In Australia, horse racing contributes more than $1,14

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billion to the economy each year (horsecouncil.org.au).

The best horses are valued not only for their performance, but also for their ability to generate enormous incomes, both for the nation and for the equestrian federations within the 'equine industry'. International and national governing bodies and organizers of horse competitions, such as Fédération Équestre Internationale (FEI), emphasize the importance of the welfare of horses through applicable regulations (www.fei.org). This suggests that horses competing in races and other competitions should have high levels of welfare.

However, the findings of many studies indicate the occurrence of irregularities in aspects of the use of horses for sport, including nutrition (Williamson et al., 2007; Brunner et al., 2012; Brunner et al., 2015; Pratt-Phillips, 2016), housing (Werhahn et al., 2011), training methods (Warren-Smith and McGreevy, 2008; Valenchon et al., 2017), observable injuries (Greve and Dyson, 2013; Trump, 2014; Cook and Kibler, 2019; Tuomola et al., 2019), and excessive stress (Górecka-Bruzda et al., 2015; Jastrzębska et al., 2017; Redaelli et al., 2019). Horses living in natural conditions forage for a significant part of the day, eating multiple times and covering considerable distances (Harris, 2007; Ransom and Cade, 2009; Górecka-Bruzda et al., 2020). Modern horse management practices involve keeping them in stalls and feeding them limited amounts of roughage and large amounts of concentrates, with limited frequency of meals (Jansson et al., 2006; Williamson et al., 2007; Direkvandi et al., 2016). This may reduce feed digestibility and contribute to the development of stomach ulcers and colic, as well as stereotyped behaviour (Andrews et al., 2005; Cooper et al., 2005; Thorne et al., 2005). Participation in competitions is preceded not only by long and intense exercise but also by periods of limited space in the box (Werhahn et al., 2011). Management practices also include keeping horses in stables and in social isolation (Horseman et al., 2016). Many equestrian coaches lack a proper understanding of positive and negative reinforcement in horse training, and release of pressure is considered to be considered the most effective reward (Warren-Smith and McGreevy, 2008). The horse's locomotor system, which is often exposed to significant loads irrespective of the discipline, may suffer injuries and fractures and diseases of the muscles, joints, and ligaments, constituting a major problem (Trump, 2014; Dzierzęcka et al., 2007; Nagy et al., 2012; Hill et al., 2015). Inappropriate horse tack, e.g. bridles, bits, and saddles, may cause pain (Cook and Kibler, 2019).

This review aims to illustrate the extent and complexity of problems indicative of the difficulties encountered in ensuring the well-being of sport horses during training, management and activities crucial to the use of horses in various sports disciplines.

MATERIAL AND METHODS

The first stage of the study was a review of the literature in English and Polish. The search was carried out in online databases: Google Scholar, Scopus, Web of Science, and Science Direct (without restriction to year). The second stage was selection of scientific papers (articles, conference papers, and PhD theses) based on the title and abstract. The selected documents were archived in the literature database. In addition, we reviewed the bibliography of the documents to find other relevant titles on s given topic (the 'snowball' search method).

Nutrition practices

Nutrition has been indicated as crucial to survival in the 'Five domains' model, in addition to environment and health (Mellor et al., 2015; McGreevy et al., 2018). Feed intake during slow movement is species-specific (Ransom and Cade, 2009; Miraglia et al., 2008; Dowler et al., 2012; Topczewska, 2013), and consumption of roughage with low energy concentration per unit mass is required for proper functioning of the digestive tract. Restricting roughage content in favour of concentrated feed, altering its composition and processing to ease digestion, and limiting the time allotted for feed intake is plainly in conflict with the needs of horses. Such restrictions result in gastrointestinal disorders and often in stereotypic behaviours (Andrews et al., 2005; Goodwin, 2007; Cooper and McGreevy, 2007). Also, performance horses are usually fed relatively low-roughage, highly hydrolysable carbohydrate diets and thus have a higher prevalence of gastric ulcers compared with pastured horses (Andrews et al., 2005).

Nutrition in performance horses can vary depending on the discipline. Horses participating in competitive equestrian sport must be prepared for either short but intensive or long-term effort, which requires the use of high energy concentrated feeds (Meyer and Coenen, 2013). It is recommended to administer high quality roughage supplemented with concentrated feeds in amounts appropriate for a given discipline. Irrespective of the sport discipline, in some instances these animals may receive only limited amounts of roughage, which satisfies their energy and protein needs but negatively affects gastrointestinal function during intensive training and competition (Jansson et al., 2006; Williamson et al., 2007; Luthersson et al., 2009; Brunner et al., 2012; 2015). Studies also indicate that these approaches cause an excessive supply of energy, protein and supplements (Williams et al., 2009; Hoffman et al., 2009; Verhaar et al., 2014; Agar et al., 2016; Grimwood et al., 2016; Gemmil et al., 2016; Murray et al., 2018). Another common observation is the limitation of free access to forage in pastures, which is considered the optimal means of nourishing horses (Thorne et al., 2005; Benhajali et al., 2008; 2009; McGreevy, 2012; Topczewska, 2014; Richardson and Murray, 2016). Horses' natural need for repeated feed intake in small quantities during the day (Harris, 2007) is often neglected. Gastrointestinal disorders, decreases in stomach pH (often resulting in ulcers and mucosal damage), and stereotyped behaviour (Luthersson et al., 2009; Reese and Andrews, 2009; Secombe and Lester, 2012; Muñoz et al., 2017) are just a few examples of the potential consequences of this type of management. Numerous studies have also shown that high levels of gastric ulcers have been diagnosed in about 90% of sport horses (Table 1).

Several predisposing factors for gastric ulcer (EGUS) were identified in the studies, such as the construction of the stomach (Andrews et al., 2005), nutrition (Luthersson et al., 2009; Cipriano-Salzar et al., 2019), and stress (Malmkvist et al., 2012). However, ulcers are mostly diagnosed in horses subjected to intense training and participation in competitions, as the pressure that accumulates in the abdominal cavity during such intense exercise causes stomach 'crushing; (Lorenzo-Figueras et al., 2002). Consequently, the stomach contents together with the gastric juice are moved to the squamous part, where the pH drops dramatically, which in turn favours the formation of ulcers (Orsini et al., 2009; Tamzali et al., 2011).

Table 1

Selected studies on gastric ulceration in horses competing in different disciplines

Discipline	Author	Scale of problems
Racing	Orsini et al. (2009)	79 horses - 28% had an ulcer score of 2 points or higher, with ulcers becoming more severe over time
Endurance	Tamzali et al. (2011)	30 endurance horses - prevalence of squamous gastric ulcers was 48% and 93% during the inter-season and competition season, respectively
Dressage and jumping	Malmkvist et al. (2012)	96 horses - 40,6% had lesions in the squamous part of the stomach and 55,2% in the glandular portion of the stomach
Eventing and endurance	Scheideggera et al. (2017)	26 sport horses competing at national or international levels in eventing - equine squamous gastric disease (ESGD) diagnosed in 73% of endurance and 33% of eventing horses; equine glandular gastric disease (EGGD) in 82% of endurance and 60% of eventing horses

Housing

The conditions under which sport horses are housed may seem excellent to an outside observer. Many owners believe that bright, warm stables with appropriate facilities for post-training care and regeneration ensure comfortable resting conditions. However, there is a need to raise awareness of horses' basic need for freedom of movement, which is not ensured by the limited space provided in boxes (Normando et al., 2011; Werhahn et al., 2011; Erber et al., 2013; Horseman et al., 2016; Lesimple et al., 2019). The need for horses to retain their natural, species-specific behaviours calls for the provision of a sufficiently large living space and the company of other animals of the same species in an appropriately structured social group. Being a member of a herd in a large space, which optimizes the opportunity for social behaviours, is a source of comfort for horses (McDonnell, 2003; Hausberger et al., 2005; Ransom and Cade, 2009; McGreevy, 2012). The forced movement experienced during training and competitions, e.g. jumping, dressage, or racing, does not satisfy horses' movement requirements in an optimal way, as horses in natural conditions move about mainly by walking (Miraglia et al., 2008; Dowler et al., 2012; Topczewska, 2013). Hoffman et al. (2012) showed that horses in group housing had the longest lay down time, the highest movement activity and the lowest stress load, while tied animals had the highest stress load. Horses housed in fields or paddocks are able to participate in a full range of natural behaviours, which greatly reduce stress levels. Modern housing systems for horses should aim to maximize the opportunity for equine interaction in a group box, with daily paddock movement. Restriction of movement and social contacts, coupled with the use of concentrated feed, may result in both somatic and emotional disorders. Confinement to boxes is also associated with social deprivation, which, like boredom, promotes stereotypic behaviours (Cooper and McGreevy, 2007; Normando et al., 2011; Werhahn et al., 2011; Horseman et al., 2016; Lesimple et al., 2019). Ruet et al. (2019) showed that the more time horses spent in individual boxes, the greater was their risk of persistent unresponsiveness to the environment, which may be similar to depression in human beings. Likewise, Sigurjonsdóttir and Haraldsson (2019) have stressed the importance of group housing of horses to ensure the fulfilment of their social needs. They also demonstrated depressed levels of aggression in such groups, which may reduce injuries in sport horses. The composition and stability of groups are of great importance with respect to aggression levels and opportunities for establishing bonds. Horses were less agonistic in groups with young foals and where group membership was stable, and also when there was a stallion in the group (Sigurjonsdóttir and Haraldsson, 2019). However, sport horses kept in individual boxes are rarely taken out for outdoor activities, or are taken out individually for fear of potential injuries (Werhahn et al., 2012). As a result, it is difficult or impossible for horses to satisfy their need for free, unforced movement, group interactions, foraging, and play. All of these shortcomings favour the occurrence of stereotyped behaviour of increasing severity (Cooper and McGreevy, 2007; Normando et al., 2011).

Sport horses are relatively often clipped, while the routine use of blankets impairs temperature control processes and may result in decreased resistance (Hartmann et al., 2017; Steinhoff-Wagner, 2018). Covering horses with blankets at the end of summer is a method popularly used to limit winter hair growth.

Health disorders

Experience of pain, mutilation and disease by sport horses

Damage to the locomotor system is a health problem that significantly limits the horse's training or participation in competitions. It is also one of the most common reasons for eliminating horses from endurance competitions, where lameness can reach up to 80% (Nagy et al., 2017). The early use of young horses with insufficiently developed muscles and skeleton for riding purposes can lead to severe physical ailments (Dzierzęcka et al., 2005; Murray et al., 2010; Trump, 2014), including fatigue fractures, which are the result of excessive strain. The lack of maturity of the locomotor system in Thoroughbred horses at the start of their racing training career is associated with increased occurrence of trauma to the locomotor system. Dzierzęcka et al. (2007) studied the frequency and type of injuries in two-year-old Thoroughbred horses in racing training and found limb disorders in 60,4% of this population. Most of the cases involved ailments of the muscles, tendons and ligaments, as well as the bones. Fractures affected mainly breast bones (85,1%) (Dzierzęcka et al., 2007).

Surfaces that are too soft can cause damage to soft tissues, muscles, tendons, hooves, joints, and bone tissue (Symons et al., 2016; Tanner et al., 2016). Hobbs et al. (2014) studied surface unevenness, hoof-surface interaction, and its risks for the horse. They emphasized the need to improve the accuracy of mechanical and biomechanical measuring techniques for estimating the risk of injury to horses and riders. Hernlund et al. (2010) studied the hoof landing characteristics of show-jumping horses landing on two different arena surfaces after jumping 1,30-1,50 m fences. They demonstrated that the landing and hoof damage varied substantially between the limbs. A study by MacKinnon et al. (2015) on the impact of the training track surface on the occurrence of stress fractures showed that as many as 31,7% of horses training on a synthetic surface had stress fractures, compared to 23.0% of those training on a dirt surface. However, Hernlund (2016) emphasized that injuries are difficult to associate with surface properties because their aetiology is multifactorial and they often occur after a long time. There is a need for further research on the impact of surface type on the occurrence of limb injuries in horses competing in various disciplines. High rates of such incidents (Table 2) may be associated with the type of surface.

Table 2

Selected studies on limb injuries in horses competing in different disciplines

Discipline	Author	Scale of problems
Show jumping	Trump (2014)	311 horses, injuries to suspensory ligament (SL) – 28,6%, injuries to superficial digital flexor tendon (SDFT) – 23,8%
Dressage	Murray et al. (2010)	In a questionnaire sent to all 11,363 registered members of British Dressage in 2005, the owners reported that 33% of horses had been lame at some time during their career
	Trump (2014)	160 horses, injuries to suspensory ligament (SL) – 41,6%
Eventing	Trump (2014)	52 horses, injuries to superficial digital flexor tendon (SDFT) – 50,0%
Endurance	Trump (2014)	21 horses, injuries to suspensory ligament (SL) – 31,8%, injuries to digital flexor tendon heath (DFTS) – 31,8%
	Nagy et al. (2012)	190 horses, lameness in 80,0% of endurance horses at some point during their careers and 53,2% in the previous 12 months
Endurance	Paris et al. (2021)	235 endurance horses, 351 orthopaedic injuries detected in 76,6% of the horses, with 27,1% affecting the fetlock area, 21,4% the proximal portion of the metacarpal area, 21,1% the foot, 12,8% the tarsus, 9,1% the mid-portion of the metacarpal area, and 8,5% other sites. High suspensory disease (21,4%) was the most common condition, followed by arthropathy of the metacarpo- or metatarsophalangeal joint (19,4%) and solar pain (14%).

Injuries of the locomotor system most often involve the thoracic limbs (Murray et al. 2010, Ramzan and Palmer 2011, Trump 2014, Maeda et al. 2016, Spargo et al. 2019) or hind limbs in dressage horses (Marneris and Dyson, 2014), while tendon injuries are the cause of about 28% of lameness in sport horses (Caston and Burzette, 2018). Surveys conducted among endurance horses have shown that about 80% of horses have experienced lameness at least once in their careers, and 80% in the last 12 months alone. Tendencies for recurrent episodes of locomotor dysfunction were observed as well. It is worrying that a veterinarian was consulted in only 52% of lameness cases.

Exercise-induced pulmonary haemorrhage (EIPH) as a result of excessive effort relative to species predisposition, is reported in about 70-80% of sport horses of varied breeds (Poole and Erickson, 2016; Morales et al., 2017). Horses running over shorter distances showed a higher incidence of EIPH (Morales et al., 2017). Nonetheless, even less profuse haemorrhage can cause chronic lung inflammation and subsequent lung fibrosis (Richard et al., 2010; Crispe et al., 2017; 2019). Hyperthermia, dehydration, lameness, and colic are relatively often observed in horses competing in long distance races (Nagy et al., 2012; 2017), while gastric ulceration occurs in 93% of individuals starting in distances of 90-160 km (Tamzali et al., 2011).

Appropriate regulations governing horse use ought to minimize or eliminate injuries. This largely involves the use of appropriate and personalized equestrian lines, bits, saddles or harnesses. An inappropriately selected bit can cause adverse effects such as wounds and abrasions on the edentulous parts of the gums or injuries to the palate (Cook, 1999; Cook, 2003; Mata et al., 2015; Cook and Kibler, 2019). Eisersiö et al. (2015) studied the distribution of rein tension during entire riding sessions. Gait movement, the rider's position in the saddle, the exercise performed, the horse's level of training, interactions between rider and horse, and disparities of the left or right rein should be considered in assessing rein tension. Mata et al. (2015) found frequent damage in the mouth area in racehorses and demonstrated correlations with the age of horses and the duration of use in sport (Table 3). The gag bit was the only bit type associated with tongue injuries in race horses (Mata et al., 2015).

Uldahl and Clayton (2019) researched the association of spurs, bits, nosebands and whips with injuries in horses during competitions in four equestrian sports in Danish Equestrian Federation competitions: dressage, show jumping, eventing and endurance. Most of the changes in the mouth were observed in horses taking part in dressage and increased with the level of competition, while spur length was associated with changes on the sides of the horse. The authors noted that oral lesions or blood were visible at the commissures of the lips in 9,2% of horses and increased with the level of competition.

Some of the elements of the bridle and bits or reins (Hawson et al., 2014; McGreevy et al., 2017) are less comfortable for horses, mainly due to obstruction of free movement and the location of the tongue, thus causing pain (Quick and Warren-Smith, 2009). A tight noseband and noseband strap prevent the horse from opening its mouth, causing discomfort, pain, and tissue damage, thus limiting normal and species-specific behaviour (Fenner et al., 2016; Cook and Kibler, 2019). Research conducted by Doherty et al. (2017) during dressage and eventing activities at both national and international levels indicated that the International Society of Equitation Science (ISES) taper gauge could not be inserted under the noseband of 44% of horses (Table 3) (Doherty et al., 2017a). Tight nosebands can impair blood flow (McGreevy et al., 2012). A study by Fenner et al. (2016) found that a tight strap under the noseband led to elevated heart rate and increased eye temperature, which are indicators of a physiological response to stress.

The posture of longitudinal neck bending, referred to as rollkur or hyperflexia, causes breathing difficulties and damage to muscles and tendons (Christensen et al., 2014: Lashley et al., 2014: Mellor and Beausoleil, 2017). Despite the many studies confirming the increasing overload of the lower part of the neck, causing discomfort and stress as well as somatic disorders (von Borstel et al, 2009; McGreevy et al., 2010; Kienapfel, 2011; Zsoldos and Licka, 2015; Rhodin et al.. 2018), it is still used in training practice. Forcing this posture also significantly reduces the horse's field of view and prevents the use of the neck to restore balance, which may lead to learned helplessness (McGreevy et al., 2010). Learned helplessness is a psychological condition that can arise after exposure to unpredictable aversive situations that the horse has no control over and from which it cannot escape (Doherty et al., 2017b). Riders or trainers unaware of this process may apply stronger pressure (in the form of spurs, whips, and sharper bits), which may cause pain or fear. It should be noted that definitive diagnosis of learned helplessness in a horse is difficult, as the condition is not accompanied by measurable changes in clinical parameters (Doherty et al., 2017b).

Table 3

Selected studies on mouth injuries in horses competing in different disciplines

Discipline	Author	Scale of problems
Racing and polo	Mata et al. (2015)	50 polo ponies and 50 race horses, 53% had bone spurs. Higher occurrence and significantly different levels of oral trauma severity in race horses: e.g. commissure ulceration – 53% in race horses and 30%, in polo ponies
Racing	Tuomola et al. (2019)	261 horses, 84% had acute lesions in the bit area and 4% had only old lesions. Among the 261 horses, 56% had more than one lesion, 52% had acute lesions. The inner lip commissure was the most common lesion location, observed in 39% of horses. Horses wearing thin (10-13 mm) (OR 3.5, CI 1,4-8,7) or thick (18-22 mm) (OR 3.4, CI 1,4-8,0) bits had a higher risk of moderate/severe lesion status than horses wearing middle-sized (14-17 mm) bits.
Eventing	Tuomola et al. (2021)	The rostral part of the oral cavity (the bit area) of 208 event horses (127 warmbloods, 52 coldbloods, and 29 ponies) was examined in a cross-country test. Acute lesions were observed in 52%.
Dressage	Fenner et al. (2016)	12 horses wearing a double bridle and crank noseband. In all horses there was no space under the noseband; increased heart rate and increased eye temperature compared with baseline readings, indicating a physiological stress response.
Eventing and dressage	Doherty et al. (2017a)	Noseband type, position, width and tightness were collected from 354 eventing horses and 334 dressage horses. In 44% of competition horses at the national and international level the nosebands were tightened to such an extent that the ISES taper gauge could not be inserted under the noseband (classified as zero fingers' tightness).

Improperly fitted saddles can cause folliculitis (referred to as acne) and pain and damage to the back and spinal muscles (Greve and Dyson, 2013; Dyson et al., 2015; Martin et al., 2016), as well as injuries and abrasions (Dyson et al., 2015). Dyson et al. (2015) demonstrated swellings under the saddle panels after exercise, dry patches, especially under the front of the saddle, scabby skin lesions, white hair under the cranial aspect of the saddle, reflecting chronic pressure from either a twisted tree or an overly narrow gullet, and muscle atrophy, especially caudal to the scapulae. Generalized muscle atrophy may reflect back stiffness and impaired function due to the pain induced by the saddle-rider combination. Asymmetrical, mismatched saddles are common causes of hind limb lameness (Greve and Dyson, 2013; 2015). Greve and Dyson (2013) reported a significant association between saddle slip and hind limb lameness. Shoeing for maximum performance in special gaits, e.g. tölt, may in the long term overstrain the locomotor system (Waldern et al., 2013). Although the soring techniques used during training to encourage specific limb lifting are not acceptable, they are still used, so efforts should be made to control their use (Rollin 2000, McLean and McGreevy 2010, Dane 2011).

The use of whips and spurs is still accepted in the regulations of many disciplines of horse sport. Existing regulations specify the acceptable length and type of whip and spur depending on the discipline (Hood et al., 2017; Anonymous, 2019; FEI Eventing, 2019). Governing body rules and regulations refer to whip use in terms of the frequency, location and method of hitting. Research and analysis regarding whip use has been conducted by McLean and McGreevy (2010), Evans and McGreevy (2011), McGreevy and Oddie (2011), McGreevy et al. (2012), Noble et al. (2014) and Hill et al. (2015). It is estimated that whips are used more often by jockeys than stipulated in the regulations, as they strive to achieve the best possible results (McGreevy et al., 2013; Hood et al., 2017). McGreevy et al. (2012) have questioned the possibility of effective monitoring of the use of whips as well as the post-impact acceleration of horses. High-speed footage of horses at the end of races reveals numerous unreported breaches of the rules surrounding whip use, with the unpadded section of the whip making contact in 64% of impacts. McGreevy et al. (2013) and Noble et al. (2014) showed that the use of the whip with forehand action results in greater force and pressure on a horse than in the case of a backhand grip. Further studies regarding the use of the whip are needed, especially in terms of horses' exposure to discomfort and pain (Hood et al., 2017).

The regulations of the Fédération Équestre Internationale (FEI) precisely define what substances are acceptable and in what concentrations, including anti-doping controls to detect the use of various illegal substances. Control tests, however, have demonstrated the use of unauthorized or illegal stimulants (The Guardian, 2014). Moreover, irritating substances are rubbed into the limbs of jump horse limbs during training to force them to lift their legs higher (Kremmer, 2017; Fragkaki et al., 2017). Gene doping is currently providing new means to improve horse performance (Wilkin et al., 2017), so there is an urgent need to detect such genetic manipulations (Tozaki et al., 2019). Recent years have seen rapid progress in genetic technologies, increasing the significance of specific genes in horse performance, including the development of novel therapies for diseases and injuries. DNA tests for race horse performance have been available since 2000 (Wilkin et al., 2017). Genes capable of affecting strength, speed, fatigue resistance and mental aptitude can be exploited in gene doping. The urgency is greater given that the effects of such measures are difficult to determine in terms of the safety, health and welfare of horses.

Sources of fear and stress for sport horses

Bartolome and Cokram (2016) analysed the impact of stress on the performance of sport horses, including possibilities of reducing stress to enhance welfare. The significance of negative reinforcement and punishment (McGreevy and McLean, 2009; Valenchon et al., 2017), as well as horse training techniques (Warren-Smith and McGreevy, 2008) was analysed as well. Horses have an evolved tendency to avoid pressure (both physical and psychological) by moving away. Horse training that exploits this relies on negative reinforcement (NR) rather than positive reinforcement (PR). Furthermore, horse trainers are largely unaware that they are using NR in training. Negative reinforcement is the removal of an aversive stimulus (that creates discomfort) from the horse when it produces the desired response. For example, pressure is applied to the horse's sides with the rider's legs, the horse moves forward, and then the pressure is reduced. If the horse resists, the trainer increases the unpleasant stimulus to obtain the desired response (Table 4) (Bartolome et al., 2013; Janczarek et al., 2013; Fazio et al., 2015; Jastrzębska et al., 2017; Redaelli et al., 2019).

Table 4

Selected studies on the occurrence of fear and stress in horses competing in different disciplines

Discipline	Author	Scale of problems
Show jumping	Bartolome et al. (2013)	173 horses, measurements of eye temperature (ET) by infrared thermography and heart rate (HR), 3 h before competition, just after, and 3 h after. ET and HR were highest just after competition, 37,6±0,09°C and 97,9±0,85 b.p.m.
Endurance	Janczarek et al. (2013)	38 horses, cortisol secretion in saliva. Cortisol secretion was increased during and after exercise and competition in endurance horses, mostly in mares, horses covering the longest distances, and at high temperatures.
Show jumping	Górecka-Bruzda et al. (2015)	100 horses, conflict behaviour (head shaking HS; pulling reins out of rider's hands PR; tail swishing TS; gaping GA). The most frequent was PR, often when approaching vertical and combination fences, from 0,43±0,47 (oxer) to 0,76±0,72 (combination).
Dressage	Górecka-Bruzda et al. (2015)	50 horses, TS behaviour in horses observed most frequently, to 0,77±2,24 (pirouette to the left)
Jumping and transport	Fazio et al. (2015)	Show jumping competition and transport were shown to influence total and free iodothyronine.
Endurance	Redaelli et al. (2019)	8 horses, heart rate (HR), blood count, serum cortisol, and maximum temperatures of different body locations, measured using infrared thermography (IRT) in horses trained for endurance. All parameters increased after training, and ET correlated positively with HR.
Endurance and racing	Witkowska-Płaszewicz et al. (2021)	30 untrained Arabians, 9 endurance and 21 race horses, serum cortisol was measured. Cortisol concentration increased significantly after training and competition; in both racing and endurance horses the increase was greater after competition.

Heart rate, serum or saliva cortisol levels, body temperature, and behavioural reactions have been used as indicators of stress by many researchers (Table 4). Bartolome et al. (2013) and Janczarek et al. (2013) showed a stress reaction expressed by increased temperatures and heart rate. Bartolome et al. (2013) confirmed the occurrence of stress in horses immediately after competition and slightly milder stress before the start of the competition. Heart rate (HR) values were significantly higher for 4-year-old animals, for horses which had travelled 4 to 6 hours, and for horses that had 3 to 6 hours of daily training. Janczarek et al. (2013) demonstrated the occurrence of stress reactions in endurance horses. A higher cortisol level was noted in mares and in horses running the longest distances and at the highest temperatures.

CONCLUSION

Management practices in nutrition, housing and use of athlete horses may lead to a variety of injuries and disorders. Research by Richardson et al. (2019) revealed inadequate implementation of newly developed solutions and technologies in the equestrian sector. Moreover, Thompson and Haigh (2018) argue that practices applied in the maintenance and use of sport horses point to the urgent need to engage in discussions with the wider equestrian community. It would be advisable to open discussion in this area, to undertake actions aimed at eliminating irregularities, and to search for optimal solutions. Efforts should also be made to better apply research results to ensure a high level of well-being of sport horses used for sport.

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