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Review Article

Potential Effects of Stress on the Performance of Sport Horses

Ester Bartolomé [a,*], Michael Stanley Cockram [b]

[a] Faculty of Veterinary Medicine, Lusófona University, Lisbon, Portugal
[b] Sir James Dunn Animal Welfare Centre, Department of Health Management, Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, Prince Edward Island, Canada

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ABSTRACT

Because of its physical and physiological characteristics, the horse has a natural predisposition for use in sport. However, the use of horses as "competition tools" frequently results in several problems related to stress that directly or indirectly bias their sporting performance. Hence, the aim of this manuscript was to examine literature on the influence of stress on sport horse performance and highlight potential avenues for improvements in their breeding and welfare. The stress response is initiated when a stimulus (the stressor) is perceived as a potential threat, resulting in a combination of biological responses designed to alleviate the effects of the perceived stressor. Stress can have positive as well as negative effects on the body helping the animal to cope with routine short-term stressors that in some circumstances can enhance performance, but in others, it can impair performance. A good sport performer has a combination of superior conformation, an appropriate temperament, a healthy physical condition and primed physiological mechanisms, and function for optimal fitness that keeps the horse performing well. In addition, it is more valuable if it has the appropriate genetic background and good reproductive ability. How stress can potentially affect these characteristics is discussed in this review. The development of a broader selection strategy for breeding of sport horses that takes into account aspects as conformation, temperament, genetics, health, and the physiology of the horse, together with an adequate control of the environment, is likely to improve the welfare of horses during competitions.

1. Introduction

The horse is an extraordinary athlete, with incredible speed and endurance abilities developed as the result of their evolution as grazing animals. Horse domestication has subsequently modified or enhanced these desirable characteristics by selective breeding, and horses have been adapted to a large variety of uses according to their main aptitudes. Hence, large, heavy breeds of horses were bred for draft work and used in either agricultural or military work, whereas lighter horses were bred for speed and endurance and were used mainly for transportation, herding, and sport [1]. In general, the athletic capacity of a horse is attributable to physiologic adaptations from their time living in the wild, such as their capacity to provide an explosive effort to escape from predators, becoming a species with superior athletic ability [1,2]. This "natural reaction" is commonly known as the "flight-fight response." It is just one mechanism evolved to cope with daily novel stimuli, hence improving the adaptation of the animal to its environment [3]. On the other hand, constant exposure to stressors can result in a nonadaptive response and hence potentially cause deleterious effects on the animal's physiology [3–7]. As sport animals, horses frequently

* Corresponding author at: Ester Bartolomé Medina, Lusófona University, Campo Grande 376, 1749-024 Lisbon, Portugal.
E-mail address: p5016@ulusofona.pt (E. Bartolomé).

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had several problems, derived from their use as "competition tools," pushing them to limits that would not normally be achieved in the wild [2].

Hence, stress could appear either as an enhancer or as a limiting factor for the sport ability of the horse, thus determining the performance obtained [6–9]. Given the international scope of the equine industry, with the continuous trade of horses and a recent increase in the exchange of genetic material in sport horse breeding [10], obtaining poor performance (or even failure to compete at all) due to stress could seriously affect the economic value of the animal and hence the value of its semen/ova. Thus, knowing the factors that produce stress and hence bias the performance ability of the horse is of great interest for not only riders or horse breeders, but for the whole equine industry.

Hence, the main aim of this manuscript was to examine literature on the influence of stress on horse sport performance to highlight potential avenues for improvements in sport horse breeding and welfare.

2. Stress in Sport Performance

2.1. What Is Stress?

Stress is an ambiguous term used to define a wide range of responses by the animal to its environment. There are many definitions of stress. However, most definitions consider that "… stress is the recognition by the body of a stressor and therefore the state of threatened homeostasis; stressors are threats against homeostasis; and adaptive responses are the body's attempt to counteract the stressor and re-establish homeostasis" [11]. A key part of the response to a stressor is the recognition by the central nervous system of a stimulus perceived as a potential threat to body homeostasis. In fact, the "perception of threat" from the animal is crucial, no matter whether it comprises a real danger [12]. Once the central nervous system perceives this potential threat, it develops a biological response that consists of a combination of biological "defense responses" that will work together (either all or only some of them) to attempt to alleviate the effects of the perceived stressor: the behavioral response, the autonomic nervous system (ANS) response, and the neuroendocrine response [3].

The behavioral response is the most biologically economical and is usually the first response shown by the animal. There are a number of different behavioral patterns indicative of stress in any animal species [13]. However, as the behavioral response is usually stressor and animal specific, "general" behavioral stress responses that animals show in every situation regardless of the type of stressor are ill defined [14].

The ANS is associated with the well-known "flight or fight" response [15]. When stimulated, it affects a diverse number of biological systems, including the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla [16]. Both branches of the ANS, the sympathetic nervous system (SNS), and the parasympathetic nervous system (PNS) are stimulated during exercise. The PNS increases in the beginning of the exercise, activating the SNS, which stimulates a systemic release of catecholamines (epinephrine and norepinephrine) that potentiates the response to exercise, increasing muscle blood flow and mobilizing glycogen and free fatty acids to fuel exertion [17,18].

Last, the neuroendocrine response, mediated by the hypothalamus–pituitary–adrenal (HPA) axis, can produce a release of cortisol that can have broad, long-lasting effects on the body, regulating a range of biological functions, such as immune competence, reproduction, metabolism, and behavior [3].

At least two general types of coping strategies can be found when confronting stress: active copers or "proactive horses" and passive copers or "reactive horses" [20]. The proactive response is mainly characterized by active behavioral reactivity such as the "fight-flight response" (fight and aggressive-dominant behavior or flight and fearful behavior), predominance of the SNS, and low HPA axis reactivity. On the other hand, the reactive response involves behavioral inhibition, with lower locomotion, immobility, freezing behavior, or withdrawal; predominance of PNS; and high HPA response [21].

A diagram describing the stress process is shown in Fig. 1.

2.2. Stress Versus Distress

Stress does not always result in a negative influence on body homeostasis, as it is one of the physiological mechanisms that animals have evolved to cope with normal short-term stressors that are routinely encountered [3]. Thus, in these cases, the biological costs of the stress response are lower than the animal's biological reserves to cope with them. The problem comes when this balance is broken, as then the resources demanded from the stress response must be shifted away from other biological functions of the animal, such as reproduction or growth. This situation has been described as "distress" rather than stress [3]. On the other hand, Sanford et al [22] made a further distinction between distress and short-term, adaptive physiological stress stating that during distress, the animal is likely to be aware that is making an increased effort to respond to a stimulus, whereas during "physiological stress," the animal is unaware of having to make a homeostatic response to it. This difference has significance to studies of animal welfare. Distress implies that an animal is experiencing a negative emotional state [4], thus affecting its welfare.

However, when considering sport horses, a stress response during a competition could have either positive or negative consequences on performance. During normal exercise activity, the sympathoadrenal axis and HPA functions are activated, increasing heart rate and plasma cortisol concentration in the horse [19,20]. Cortisol has many positive and desirable physiological functions that, in the short term, might be beneficial for the adaptation of the horse to exercise demands. These include reducing inflammation, stimulating movement, and raising blood glucose concentration. Healthy sport horses recover quickly once the threatening stimuli from the competition day are finished, hence decreasing their plasma cortisol