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Rider and Horse Salivary Cortisol Levels During Competition and Impact on Performance

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ABSTRACT

During competition, stress may affect riders and horses. This stress can affect health, welfare, and/or performance. Our aim was to quantify stress levels during competition in horses and riders. We also searched relationships between these stress levels and performance. Twenty riders and 23 horses were followed up during a show-jumping event (26 courses) held at a riding school. Regular saliva samples taken from horses and riders were assayed to evaluate cortisol levels. We studied salivary cortisol evolution during the days of competition. There was no correlation between instantaneous sampling on horses and their riders. However, we did find a parallel between horse and rider salivary cortisol evolution curves, with a similar peak, reached 20 minutes after the course. The increase was stronger in riders than in horses. Correlations appeared between salivary cortisol concentration and performance, but stress in both partners seems to have an opposite influence on performance. Riders who showed a higher salivary cortisol increase were awarded more penalties, whereas horses that showed a higher increase in salivary cortisol performed better. Stress level measurement in rider–horse pairs would thus lead to improvement in competition conditions and performance, for horses as well as for riders.

1. Introduction

In every sport, competition induces stress. This also occurs in equestrian sports. Riders and horses can be affected by stress at various levels. Stress is not always harmful. Positive stress, called “eustress,” is even necessary for environmental adaptation. It is thus important for raising resources, for example, to perform in competition. Stress may become negative when it causes deleterious effects on health, welfare, and/or performance. Stress is then called “distress.” Distress can appear when an individual is confronted with an acute or a chronic stressor, which surpasses his adaptation capacities [1].

Competition is a mixture of various stressors (stabling, transport, novelty, rider stress, noisy public, and music). Nevertheless, only a few stress studies have been carried out in equestrian sports. One of them examined the effects of show-jumping competition on horse stress levels. Researchers took blood samples at the horse show and at home for plasma cortisol assessment. They found that competition experience had an effect on physiological stress: less experienced horses displayed higher plasma cortisol values when at rest at the show than at home [2]. Another study examined the effect of show-jumping as well as dressage on stress levels by comparing horses' stress response at a horse show and at home. They found that competition induced a significant increase in blood cortisol response in both jumping and dressage horses. They conclude that competition elicits a classic physiological stress response in horses [3].

Other researchers measured plasma cortisol concentrations before and after show-jumping competitions.

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Horses were separated, according to their competition experience and if they were transported or not just before competition. They found significant increases relative to the basal values in cortisol concentrations of all groups of horses [4]. In a preliminary study, blood samples were taken before and after an international cross event. Results showed that serum cortisol concentrations were higher after than before the cross event [5].

As largely accepted, saliva sampling is a noninvasive alternative technique for assessment of cortisol levels in horses. This method is more appropriate for physiological stress assessment in horses, even more so in competition. Saliva sampling can be performed anywhere, by every horseman on every domesticated horse, after only a short period of training. Sampling is easy and stress and pain free [6]. Therefore, we preferred to collect saliva than blood to measure the activity of the hypothalamo-pituitary-adrenal axis (HPAA). This salivary corticosteroid is largely used as a stress hormone in humans [7] as well as in horses [5,8,9]. A cortisol concentration increase is observed in saliva with a delay of approximately 20-30 minutes before it is observed in blood. This has been observed in horses [6,10] as well as in humans [11].

Saliva cortisol concentrations have already been used in stress studies involving horses exposed to stressors such as a new environment [12], transport [9,13], and competition [5]. Horses' salivary cortisol basal values differed largely between individuals [5]. It was recommended to measure basal values for each individual before measuring concentrations during stress events [13].

Salivary cortisol is frequently used as a biomarker in human stress research [14]. As in horses, it reflects HPAA activity. Salivary cortisol level can express stress, but it can also be affected by different factors, such as age, gender, oral contraceptive, or medical conditions. These variables can affect cortisol binding and HPAA response [14]. To be able to relate salivary cortisol level with stress, we need to control for these variables as well as possible.

Basal values for salivary cortisol in humans are well described in the literature [7,15]. Daily cortisol secretion can be divided into two distinct phases: the cortisol awaking response and a subsequent period of decline throughout the rest of the day (Edwards et al. [2001] in [15]). Oskis et al. found a cortisol awakening response and a subsequent daytime decline period in female adolescents [15]. The mean ($\pm$ standard deviation) cortisol concentration of four saliva samples collected from 3 to 12 hours after awakening was 4.17 $\pm$ 2.05 nmol/L [15].

The essence of the competition model is that to win, the competitor must out-stress the opponent [16]. Stress, measured by cortisol, is important for the preparation of the competition, during and after the stressful situation. Most studies detect an anticipatory rise in cortisol when they collect pre-event samples (15-30 minutes before the competition) [16]. Increasing cortisol level might be important in preparing for mental and physiological demands, and might affect performance. A moderate rise in cortisol helps individuals deal with challenges in competition (Stansbury and Gunnar [1994] in [16]). "First, it marshals resources needed for physical activity. Second, it positively affects memory, learning and emotion and thirdly, cortisol serves a homeostatic function by regulating other stress sensitive systems" [16]. Some studies have found that extreme elevations in cortisol lead to poor performance (Erickson et al. [2003] and Cumming et al. [1983] in [16]). Kivlighan et al. [16] found that endocrine response to stress varied by gender and by experience of competition. Responses were also different depending on when samples are taken in anticipation of, in response to, or after the competitive event. Another study, performed on judoists, shows an anticipatory rise in serum cortisol [17]. They also found significantly higher serum cortisol levels in winners in comparison with losers.

The neuroendocrine response to competition is thus complex and depends on subjective factors related to the cognitive evaluation of the situation rather than on the outcome itself [18]. Exercise leads to an increase in cortisol, in humans as well as in horses [19-24]. However, by taking saliva samples during a board game competition in Japan, researchers found that changes in salivary cortisol after competition are associated with winning and losing, even if this game does not need physical exercise [25]. Some studies have found that salivary cortisol is increased in current smokers, compared with nonsmokers [26]. Other studies also found that smoking a cigarette activates the HPAA in habitual smokers [27,28].

Our aims were to quantify stress levels in competition using salivary cortisol levels, following their kinetics in horses and riders, and comparing these stress levels with the performances achieved.

2. Material and Methods

In the present study, we tried to standardize external factors that could influence rider and horse stress. We observed horses and riders at the same place, during the same competition, and with the same experimental protocol.

We observed 20 riders and 23 Warmblood horses before and during a jumping event, organized by a riding school. The riders' school is the "Ecole provinciale d'élevage et d'équitation de Gesves" (EPEEG) in Belgium. We followed 26 jump courses spread over two consecutive days. The six riders and three horses followed twice were observed on two different days.

Riders were young women between 17 and 20 years of age, all students at this school. Participants were thus a relatively homogeneous set of female adolescents; they lived 5 days a week at the school, where they followed the same daily routine (horse riding training and classroom lessons). They had ridden 6 d/wk for at least 2 years. They all have previous competition experience. They were also all postmenarcheal. Four of them (20%) were regular smokers. All participants provided written informed consent.

Horses were 12 mares and 11 geldings whose ages ranged from 6 to 11 years. Horses had all been stabled at the school for at least 1 year. They had been trained 6 d/wk (jumping and dressage lessons) for at least 2 years. Riders were the horses' owners, and pairs were used to working together.

Pairs performed over fences between 90 and 110 cm in height. During the 2 days of competition, we took saliva samples from riders and horses, following accurate timing: