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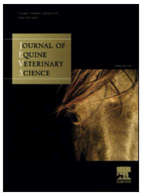

Original Research

Riding Simulator Training Induces a Lower Sympathetic Response in Riders Than Training With Horses

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ABSTRACT

Recently, equestrian riding simulators have become available for dressage, jumping, polo, or racing. In this study, we have compared salivary cortisol, heart rate, and heart rate variability (HRV) variables, standard deviation of beat-to-beat interval and root mean square of successive beat-to-beat differences, in 12 riders jumping a course of obstacles on a horse and on a riding simulator. Salivary cortisol concentrations from 60 minutes before to 60 minutes after simulator training were higher ($P < .05$) than those during training with a horse but did not change acutely with the simulated or real show jumping efforts. This indicates that the novel situation of simulator training was perceived as more stressful than routine training with a horse. Heart rate of the riders increased both on a horse and on a simulator ($P < .001$) but reached significantly higher values on the horse versus the simulator (175 ± 3 vs. 123 ± 5 beats/min, $P < .01$). Both HRV variables decreased ($P < .001$) during the simulated course and on a horse. From 30 minutes before to 30 minutes after the jumping tests, HRV variables were higher in association with the simulated course versus the course jumped with a horse (standard deviation of beat-to-beat interval, $P < .05$; root mean square of successive beat-to-beat differences, $P = .056$). The changes in heart rate indicate that simulator training required less physical effort than training on a horse. Based on differences in HRV, training with a horse was associated with a more pronounced sympathetic tone than simulator training. Although simulator training in principle mirrored the situation on a horse, the demands on a horse were more complex.

1. Introduction

Simulator-based training is used in a broad variety of fields. Although flight simulators for the training of air pilots are well established [1], simulators are gaining increasing importance to train diagnostic and surgical skills in medicine [2,3] and veterinary medicine [4]. Although the first riding simulator was developed over 25 years ago [5], such systems have not been widely used in equestrian training. Riding simulators can contribute to an objective assessment of the rider's position in the saddle [6,7] and the signals (aids) through which the rider controls the horse [8]. Schooling both the seat of the rider and consistency of the rider's aids on a simulator will contribute to improving equestrian performance [9]. In addition, horse riding simulators have been suggested to improve physical abilities and coordination of elderly people [10,11], children with cerebral disease [12],

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patients with chronic back pain [13] and to reduce anxiety in novice riders [14]. Recently, a new generation of simulators have become available which are aimed specifically at equestrian training [8]. They can be programmed for dressage, show jumping, polo, or racing and respond interactively to the aids of the rider. To the best of our knowledge, simulator-based training has not been compared to equestrian training with horses. Horse riding is both a physical and emotional challenge for the rider [15–19]. To what extent the demands of horse riding are mirrored by simulator training is so far unknown.

Continuous recording of heart rate is a simple technique for the evaluation of physical efforts. Heart rate variability (HRV), that is, slight variations in the beat-to-beat interval represent the balance of the sympathetic and parasympathetic branch of the autonomous nervous system on the sinus node of the heart. Decreases in HRV indicate a shift toward sympathetic dominance as occurs during a stress response while increased HRV is a result of parasympathetic dominance [20]. Physical efforts and stress situations also stimulate cortisol release from the adrenal cortex. Cortisol can be analyzed in blood plasma but more easily in saliva. In addition, salivary cortisol represents the nonprotein-bound and thus biologically active fraction of total plasma cortisol [21].

In this study, we have analyzed heart rate, HRV parameters, standard deviation of beat-to-beat interval (SDRR) and root mean square of successive beat-to-beat differences (RMSSD), and salivary cortisol concentration in riders jumping a course of obstacles with a horse and riding a virtual course of obstacles on a riding simulator. We hypothesized that a jumping simulator elicits a near identical physical effort in riders but a lower stress response than jumping with a horse.

2. Materials and Methods

2.1. Riders

The riders participating in this study were trainees in a 2-year program at the Brandenburg State Stud in Neustadt (Dosse), Germany (N = 12, six female and male each). Age was 21.5 ± 1.4 and 19.8 ± 2.2 years for female and male riders, respectively. As ranked by their trainer, all riders had nearly the same level of experience. On the scale of the German Equestrian Federation for equestrian competitions from 1 (E = entry level) to 5 (S = advanced or difficult level), they were ranked as level 3 (L). The riders were used to ride several horses nearly every day but had never trained on a riding simulator before. Informed consent was obtained from all riders before they participated in the study. None of the riders reported health problems throughout the study period.

2.2. Horses and Riding Simulator

The horses participating in this study were all geldings of the Brandenburg State Stud at Neustadt (Dosse), Germany, used in the riding school of the stud. Age of the horses was 11.0 ± 3.2 years. They were kept in individual loose boxes on straw or wood chippings and fed oats and pelleted concentrates three times daily and hay twice daily. Water was freely available at all times.

The riding simulator used in the study was developed for training riding abilities by imitating horse movements (interactive jumping and cross-country simulator; Racewood Equestrian Simulators, Tarporley, UK). The simulator can be controlled by leg and rein pressure from the rider and with independently moving head, neck, and body it simulates the reaction of a horse to any action of the rider. Besides riding in all gaits, the simulator can imitate jumping obstacles viewed on an interactive screen in front of the rider which gives also information about the distance to the next obstacle.

2.3. Experimental Design and Procedures

All riders had to accomplish a jumping course on a horse and simulate a jumping course on the jumping simulator. For 60 minutes before performing the jumping course on a horse and the simulated jumping course, the participants refrained from any physical activity. All riders participated in the test on a horse first and in the riding simulator test 10 months thereafter.

All tests on horses were performed in the same indoor area at the Brandenburg State Stud to which the riders and the horses were familiar. After preparing their horses, the riders mounted and walked to the arena where the warmup started with walk (5 minutes), trot (3 minutes), and canter (3 minutes) followed by jumping two obstacles at lower height. The riders then jumped a standardized jumping course with their horse (eight obstacles; height, 83–90 cm; length of the course, 310 m; average riding speed, 290 m/min). Saliva for cortisol analysis was taken at 60, 30, and 15 minutes before and at 0, 15, 30, and 60 minutes after the jumping course. Heart rate was recorded continuously from 60 minutes before until 60 minutes after jumping the course.

Tests on the riding simulator were performed at the Equitana Equestrian Fair at Essen, Germany. After resting for 1 hour, riders mounted the simulator. They started with a warmup phase (3 minutes) and one test obstacle followed by the jumping course of 13 obstacles. Theoretical length of the course was 540 m, height of the obstacles was between 90 and 110 cm, and theoretical riding speed was 270 m/min. Samplings of saliva and heart rate recordings were performed as for the test on a horse.

Tests on horses and simulator were always performed at the same time of the day between 10 AM and 12 AM.

2.4. Cortisol Analysis

For cortisol analysis, saliva was collected with cotton rolls (Salivette cortisol; Sarstedt, Nümbrecht-Rommelsdorf, Germany), which the riders placed in their mouth as described [14,15]. Salivettes were centrifuged at 1000*g* for 10 minutes, and saliva was aspirated and frozen at −20°C. For determination of cortisol concentration, a direct enzyme immunoassay without extraction [22] was used as described [23]. The minimal detectable concentration of the assay was 0.04 ng/mL, and intra-assay and interassay coefficients of variation were 4.5% and 12.5%, respectively.