

# Performance Monitoring in Equine Sports

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## INTRODUCTION

Training in equine sports is largely based on experience and intuition. To optimize the training of equine athletes, there is a need for objective measurements of biomechanical, sport physiological and behavioral parameters. These parameters can be used by trainers to improve their training strategy.

Thereby, performance of equine athletes is largely determined by the musculoskeletal apparatus of the horse. Thus far, studies on training have mainly focused on exercise physiology [7] or kinematics [1, 6, 16]. The incorporation of forces between rider and horse and behavioral observations would provide essential information when comparing riding techniques, rider levels and training programmes. This could lead to better training and increase the understanding of the rider-horse interaction.

Another important reason to develop objective measurement techniques for these parameters, related to the use of the horse, is the high incidence of musculoskeletal disorders, which rank first among the causes of wastage in performance horses. These musculoskeletal injuries are almost invariably caused by single or repetitive biomechanical overload.

Equestrian sports are mainly judged by juries and therefore face an extra challenge. It is hard to objectify the performance and welfare of these athletes. Performance in these sports is often specified as a specific combination of movements. Behavioral observation techniques can play an important role in the specification of the performance, especially in combination with sport analysis software.

We aim to enhance the understanding of the biomechanical interaction and physiological information of rider and horse in order to optimize training and performance.

## Training of Horses

Training is essential for horses to compete effectively and safely. All equine athletes undergo some type of training regime to prepare them for the level of their competition. Training prepares the equine athlete for competition by inducing the physiologic adaptations necessary to perform at a high level with minimal risk of injury, and by providing the appropriate behavioral and psychological factors essential for effective training [11]. Field testing during training and competition of warmblood sport horses can give more optimal training programs to prepare them for their level of competition.

## Aids and Forces During Riding

During the training of horses several signals (aids) are used. It is very important to understand the effect of the different aids. The following groups of aids are of interest: rein force, saddle force and force on the bridle. Next to these aids the effects of rider weight, rider leg pressure and rider balance should be evaluated. These aids are important in most equine disciplines (dressage, jumping, etc.)

The equestrian world is especially interested in the effects of training techniques that are considered less conventional, such as hyperflexion. The question is if and how these techniques can be applied without jeopardizing the welfare of the equine athlete. Recent studies have provided information on hyperflexion, but it is still questioned whether this technique is acceptable [10, 18].

## Welfare

Welfare is a very important issue in equine sports. The evaluation of welfare is mainly subjective. It would be a big step forward if more objective criteria for welfare could be developed. There is good reason to believe that force measurements can be of great help, as it is likely that there is a relationship between the forces exerted on the horse and the degree to which the welfare of the animal is affected.

## Injuries in Horses

The focus lies on overloading of the musculoskeletal system of the horse and its prevention. Overloading can be related to incorrect riding technique, training, shoeing, surface characteristics, excessive rider's weight, or riding a too young horse.

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Lameness is the most common cause of involuntary early retirement in performance horses [15]. Prevention and cure of lameness are therefore economically important for the horse industry. Loss of horses due to lameness is so frequent that insurance is expensive. There is an important welfare aspect too; lameness is becoming socially less acceptable because it affects the well being of animals.

## MATERIALS AND METHODS

Analysis of horse and rider in locomotion is done by means of development of measurement equipment and experimental work. The experimental work focuses on the comparison of different riding techniques, levels of riding experience and training programmes for horses and riders. During the experimental work motion analysis, force measurements at contact points between rider and horse (saddle, girth, stirrups and reins), sport physiological measurements (heart rate and heart rate variability of horse and rider and lactate) and behavioral observations will be combined. The results of these experiments will be translated to the equine practise. This will lead to a correct balance between loading and the physical and mental fitness of both horse and rider.

### Identify Variables

The measurement results will be compared for the different riding techniques, riding levels and training programs. Besides this the evaluation of different variables (magnitudes of forces, joint angles, force patterns) in order to identify variables that provide the best information on the difference in training and horse loading. This will create the possibility to develop a panel consisting of a restricted number of selected, well-validated, highly relevant variables for the use of measurement techniques in a practical setting (by trainers).

### 3D Kinematics

Motion of the horse and rider are recorded by high speed infrared cameras. The kinematics of the head and neck, back, limbs and centre of mass of both the horse and rider are evaluated [2, 3, 4, 5, 8, 9, 13, 14, 17].

For measurements of kinematics under field conditions, the use of high speed cameras is not practical. Inertial motion sensors might provide a user friendly alternative. For the application of inertial sensors in equine sports a combination of the data of the sensors with a biomechanical model of the horse has to be developed.

### Force Measurements

The rider provides several sensory signals to the horse that lead after processing by the nervous system to a range of locomotor behaviors. In addition, the rider influences the musculoskeletal system of the horse also directly, for instance by his or her weight and by other forces exerted on the horse. The biomechanical effects of the rider on the horse can be examined by various measurements. We use high-speed video to quantify the 3D kinematics of the bodies of rider and horse, and will measure forces

underneath the saddle, between the legs of the rider and the horse, in reins, stirrups leathers and in the girth using custom-built equipment.

### Sport Physiological Measurements

Fitness of warmblood sport horses is measured by a standardized exercise test (sub maximal) in combination with lactate measurements. Using a heart rate monitor, the heart rate and heart rate variability (beat to beat intervals) of the horse can be measured. Thereby simultaneously the GPS system will measure distance and speed during the exercise test. To assess performance and fitness lactate concentration VLa4 (velocity at a lactate concentration of 4 mmol/L) can be used. As the fitness increases, VLa4 increases. Thereby V140, V170 and V200 (velocity at heart rate 140,170 and 200 bpm) and the recovery heart rate 5 and 10 minutes after training can be used to assess performance and fitness of the horse.

### Behavioral Observations

The behavioral observations will be a combination of parameters characteristic for equine locomotion (e.g. gait, exercise) and stress-related behaviors in the ridden horse [12]. Stress-related behaviors are used because they give an indication of the welfare of the horse. These behaviors will be defined in an ethogram.

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