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Kinematic and morphological traits and the probability of successful jumps of young Brazilian Sport Horses

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ABSTRACT

In this study, logistic regression methodology has been used to identify and quantify the relationships between conformation and kinematic traits of young Brazilian Sport Horses on successful free jumps. The young horses ($n=108$) aged 22–25; 23–32 and 36–39 months old (age Classes I, II and III) recorded on five attempt jumps in each age Class over a vertical fence that was 0.60, 0.80 and 1.05 m high, respectively. Jumps were recorded by a 100 Hz camera and analyzed by the Simi Reality Motion Systems® software. Traits were selected from a previous principal components analysis and used as independent traits in a logistic regression model. The most important traits for each age Class, from 45 independent traits presented in this study were selected as follows: 17 traits were selected for Class I; 19 for Class II; and 18 traits for Class III. On the logistic regression model to the Class I only the neck angle in the stance horses was significant. The logistic regression models to the Class II and III presented kinematic related traits that were significant, such as: last stride length prior to jumping, take-off distance, forelimb height at jumping, vertical distance between humeroradial and metacarpophalangeal joint, head angle, neck angle, femorotibial angle and vertical distance between the femorotibial and metatarsophalangeal joints. In conclusion, to increase the probability of a young horse jumping successfully, it is necessary to reduce stride length prior to the fence and to increase take-off distance, thus resulting in a higher height of forelimb over the fence and also to present smaller values of head and neck angles when jumping.

1. Introduction

The Brazilian Sport Horse is a breed that was developed with the main objective to be a national breed of horses with equestrian sports abilities in Brazil. The Brazilian Association of Sport Horse Breeders – (Associação Brasileira de Criadores do Cavalo de Hipismo – ABCCH) was established in 1977 and it is a member of the World Breeding Federation for Sport Horses (WBFSH). Today, ABCCH has over 330 members with more than 20,000 animals registered (ABCCH, 2015).

Recording and analyzing images of foals during free jumping allows the establishment of kinematic patterns that can provide methods and criteria for the selection of young horses. Morphological and locomotion evaluations are important tools for horse selection adopted by the World Breeding Federation for Sport Horses (Koenen et al., 2004). Research shows that horses have the same jumping kinematic pattern when evaluated at six months and at five years old (Santamaría et al., 2002; Bobbert et al., 2005). Also, kinematic techniques used to evaluate young horses provide objective information for foal selection with jumping skills. Therefore, kinematic analysis provides an objective evaluation of horse morphology and locomotion, in contrast to the subjectivity of traditionally score systems used by breeding associations when registering animals, especially stallions (Koenen et al., 1995).

In this study, logistic regression methodology has been used to identify and quantify the relationships between conformation and kinematic traits of young Brazilian Sport Horses on successful free jumps.

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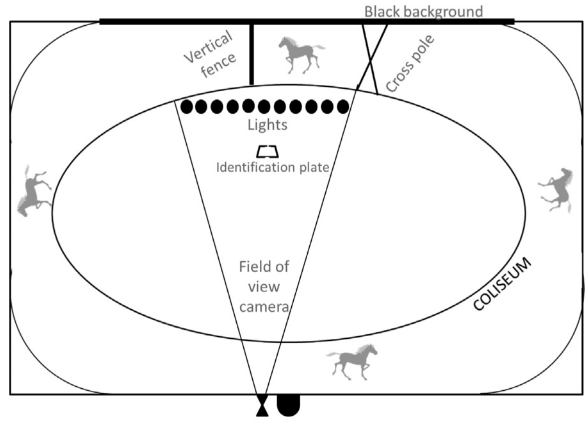

Fig. 1. Blueprint of recording setting, camera location, coliseum, lighting and obstacles.

2. Methodology

One hundred and eight untrained purebreds and crossbred young Brazilian Sport Horses, of both sexes, born and raised at the Rincão Stud Farm of the Brazilian Army were used. None of the horses had been ridden, trained for jumping or given any other kind of training.

Jumping was evaluated in three different age groups: 22–25 months old (age Class I), 29–32 months old (age Class II) and 36–39 months old (age Class III). A trial was carried out in an indoor sand riding arena of 45 × 19 m, with a black background and ten 1000-W lights (Fig. 1). An elliptic hall coliseum that allowed the horses to pass through its center was used, so the young horses would have an adequate approach to a fence at a regular canter. The camera Basler A602fc (100 Hz) and Simi Reality Motion Systems® 4.7 software program were used to measure conformation and kinematic traits. The camera was placed stationary in a sagittal plane to avoid parallax errors, 16.3 m away from the vertical fence that was situated in the center of the camera vision.

Anatomical sites on the left side of the horse's body were highlighted using 18 reflexive skin markers, according to the procedure from Godoi et al. (2014).

For each age group, the young horses were evaluated in the stance position and on five free jumping attempts, over vertical fences with heights of 0.60 m (108 animals at 22–25 months old from age Class I); 0.80 m (84 animals at 29–32 months old from age Class II) and 1.05 m (79 animals at 36–39 months old from age Class III). As they got older, the number of evaluated horses was reduced due to sickness or death. The vertical fence was preceded by a 0.45 m high cross pole, at a fixed distance, in order to ensure safe jumping conditions. The distance from the vertical fence for Class I and II evaluation was 6.5 m; and for Class III it was 7.0 m. Animals were adapted to the fence by three jumps over a lower reference cross pole. Before jumping, the horses were warmed up by walking, trotting and cantering. Throughout the experiment an expert horseman was present ensuring the safety of the young animals.

Valid jumping data were considered on the results that ones where the horse remained positioned perfectly perpendicular to the camera. Reference markings were made on both ground and fence, in order to ensure horses' locomotion linearity towards the Vertical fence. The staff was positioned next to the Cross pole and Vertical fence, thus ensuring that all jumping were made within the camera's plan of filming. Those who occurred outside such a plan were excluded from the analysis.

Jumps were classified into two categories: successful jumps (clearance of fence) and unsuccessful jumps (knockdowns, refusals or run-outs). In total, 1348 jumps, considered as dependent traits, were evaluated: 1067 were successful and categorized as 1, and 281 were unsuccessful and categorized as 0 (Zero). Independent traits were (1) stance horse morphology traits (linear traits: Table 1, and angular traits: Table 2); and (2) kinematics related traits (jump-performance: Table 3) and horse-conformation traits: Table 4).

The stance horse morphology traits, divided into linear and angular traits, were measured on the left side of the stance horse (static), with fore and hindlimbs in the perpendicular position (Godoi et al., 2013).

Kinematic related traits were divided into jump-performance and horse-conformation traits (dynamic). Jump-performance traits were related to the quality of the jumping itself, and they were measured considering the distance between two pre-established points: one on the horse's body and the second one on the fence. Horse-conformation traits were exclusively measured on the horse's body during jumping. These traits allow the evaluation of the jumping pattern according to the morphology of the young horse's body.

Traits were measured when the animal's left fore-or hindlimbs were above the fence, and evaluated using a fixed marker on the

Table 1
Description of the stance horse morphology traits – linear traits.

Stance horse morphology traits – linear traits	
Trait	**Description**
Withers height	Vertical distance measured between the highest point of the interscapular region, defined by 5th and 6th thoracic vertebrae spinous processes, and the ground
Croup height	Vertical distance measured between the highest point of the sacral tuberosity and the ground
Body length	Linear distance between humerus greater tuberosity cranial face and caudal extremely of ischial tuberosity
Neck length	Linear distance between the lateral cranial portion of the atlas wing and the mean point of scapular cranial border
Distance from shoulder to fetlock	Distance from the central area of the scapularhumeral joint to the medial third of the lateral face of the metacarpophalangeal joint of the left forelimb
Length of forearm	Distance from the central area of the humeroradial joint to the lateral medial third of the carpal joint
Length of forelimb shank	Distance between the lateral medial third of the carpal joint to the medial third of the lateral face of the metacarpophalangeal joint measured on the left forelimb
Length of forelimb pastern	Distance between the medial third measured on the lateral face of the metacarpophalangeal joint and lateral face of the proximal interphalangeal joint measured on the left forelimb
Leg length	Distance from the lateral mean point of the femorotibial joint to the lateral medial third of the tarsal joint
Length of hindlimb shank	Distance from the lateral medial third of the metatarsophalangeal joint and the lateral medial third of the metatarsophalangeal joint measured on the left hindlimb
Length of hind limb pastern	Distance between the lateral medial third of the metatarsophalangeal joint and the lateral face of the proximal interphalangeal joint measured on the left hindlimb