5th International Workshop on Linear Profiling in the Warmblood Horses

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HOW SCIENTISTS AND APPRAISERS CAN HELP EACH OTHER

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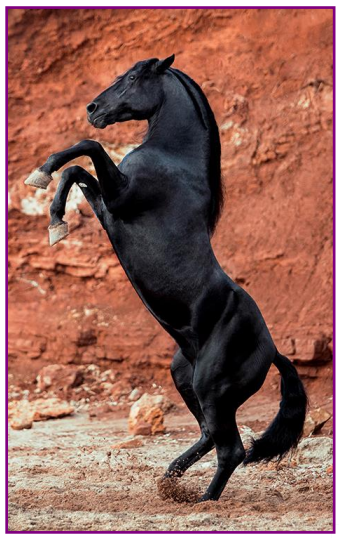
LINEAR ASSESSMENT

- Linear assessment for breeding purposes has become **common** in performance control of sport horses, because it is:
  - **Rapid, simple and cheap:** does not require previous preparation of animals. So, all population is controlled
  - **Objective** (mainly for *primary traits): the appraiser does not compare the animal with the ideal
  - **Descriptive:** includes all variability of the population for each trait. So, all differences between animals are controlled
  - **Positive:** determinates the characteristics that individuals can transmit to the next generations. So, it is interesting for breeders to improve general conformation and to correct defects
  - **Informative:** evidences the sense of deviation. So, it can be used for the genetic evaluations
  - **Flexible** in time and space: breeding evaluations are useful also if breeding objectives change

***Primary traits:** related with a body measurement, for example: length of head or length of neck.
Secondary traits: not related with a body measurement (subjective evaluation), for example: harmony or muscular development.

LINEAR ASSESSMENT

- The **quality of genetic evaluations** depends largely on the truthfulness of data collected
- In the linear methodology, it depends largely on the **quality of the appraisers** and the **adequacy of the selected traits**
- In order to obtain **suitable information for genetic evaluations** (scientists), it is essential to ensure:
  - the correct selection of traits
  - the correct evaluation of the animals by the appraisers (using the full scale and with reliable scores)



LINEAR ASSESSMENT

APRAISSERS

- **FUNCTION:** Official performance control
- **AIM:** Collect perfect data (perfect descriptions of the animals using the official sheet)

SCIENTISTS need APPRAISERS
to obtain adequate information for breeding evaluation

APPRAISERS need SCIENTISTS
to evaluate and improve their data control

SCIENTISTS

- **FUNCTION:** Official genetic evaluation
- **AIM:** Provide breeders with breeding values of animals for each evaluated trait (breeding stock catalogue)

LINEAR ASSESSMENT IN SPAIN

- Six populations use linear assessment for conformation control
- Evaluation sheets are in constant evolution as the populations, based on statistical and genetic analysis, and on **constant feed-back between appraisers and scientists**

To ensure success of Linear Assessment, scientist and appraiser have to become a TEAM in the different steps

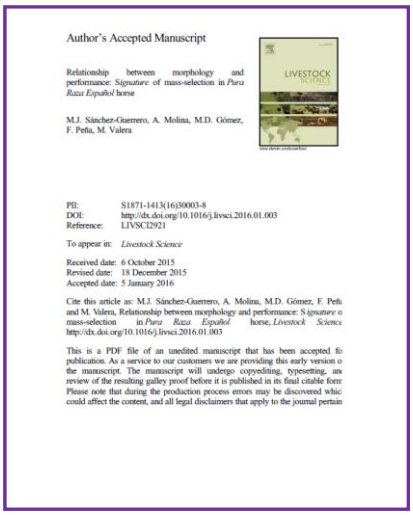
1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

- Based on collected conformation data (body measures, angles, descriptions, biokinematic traits…), different statistical and genetic tests were done to ensure:

- Adequate **variability** to allow selection and ensure differentiation of classes by <u>appraisers</u>
- No negatively **correlated** traits to avoid negative response to selection
- **Related** with performance, functional and biokinematic traits
- Adequate **heritability** level to ensure response to selection
- Mainly ***primary** traits (more objectives and with an easier measurement by <u>appraisers</u>)

***Primary traits:** related with a body measurement, for example: length of head or length of neck.
Secondary traits: not related with a body measurement (subjective evaluation), for example: harmony or muscular development.

1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)



Author's Accepted Manuscript

Relationship between morphology and performance: *Signature* of mass-selection in *Pura Raza Español* horse

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- This study allowed us to **determine the heritability and genetic correlations among the zoometric measurements analyzed**.

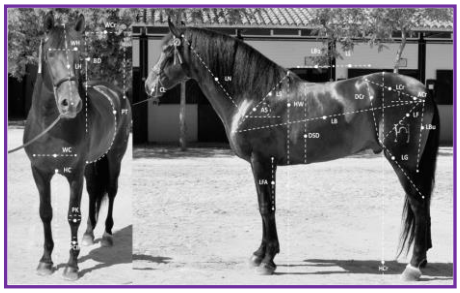
1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

26 Conformation measurements
(one record per horse)

Collected between 1980-2013

52,681 horses
(21,081 males and 31,600 females)

Aged between 4 and 23 years old



Height at withers (HW)
Height at chest (HC)
Height at croup (HCr)
Length of head (LH)
Width of head (WH)
Commissure of lips (CL)
Length of neck (LN)
Length of shoulder (LS)
Width of chest (WC)
Length of forearm (LFA)
Length of body (LB)
Length of back (LBa)
Length of loin (LL)
Length of croup (LCr)
Width of croup (WCr)
Length of Femur (LF)
Length of gaskin (LG)
Depth of croup (DCr)
Length of buttock (LBu)
Bicostal diameter (BD)
Dorso-sternum diameter (DSD)
Perimeter of thorax (PT)
Perimeter of knee (PK)
Perimeter of cannon bone (PCB)
Angle of shoulder (AS)
Angle of croup (ACr)

1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

	Heritabilities
Height at withers	0.80 $_{0.032}$
Height at chest	0.72 $_{0.029}$
Height at croup	0.74 $_{0.032}$
Length of head	0.41 $_{0.033}$
Length of shoulder	0.55 $_{0.030}$
Width of chest	0.53 $_{0.017}$
Length of body	0.39 $_{0.007}$
Length of croup	0.53 $_{0.033}$
Length of gaskin	0.50 $_{0.032}$
Depth of croup	0.45 $_{0.031}$
Bicostal diameter	0.45 $_{0.034}$
Dorso-sternum diameter	0.38 $_{0.031}$
Perimeter of thorax	0.67 $_{0.033}$
Perimeter of knee	0.50 $_{0.030}$
Perimeter of cannon bone	0.44 $_{0.031}$
Angle of shoulder	0.31 $_{0.033}$

Genetic correlations

30% between 0.20 and 0.50

57.50% > 0.50

Medium-high level

The highest was 0.97
(height at withers both height at chest and at croup)

1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

Open Access

Original study

Relationship between conformation traits and gait characteristics in Pura Raza Español horses

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Abstract

In the breeding program of breeds such as the Pura Raza Español horse, selection by gait quality is of great interest because of their use for dressage performance. However, biokinematic analyses are expensive and data processing is time consuming. So, indirect measurements related to movement quality are alternatively used for a precocious selection of the animals. The aim of this study is to estimate the genetic correlations between 13 conformation measurements and 16 biokinematic variables at trot (4 linear, 6 temporal and 6 angular) in order to identify objective selection criteria for locomotion ability. A total of 130 Pura Raza Español horses from 24 studs, aged between 4-7 years old, were measured and their biokinematic variables were obtained in experimental conditions on a treadmill. There were 155 significant genetic correlations between conformation and biokinematic traits. Croup length was the most correlated trait with biokinematic variables at trot (16), and croup width was the least correlated one (7). Forelimb length and forelimb duration were the most correlated with conformation measurements (12), whereas minimal angle of carpus was the least correlated one (5). All the conformation measurements were genetically correlated with biokinematic variables, and through these relationships when trotting, a total of 6 body measurements were selected for the indirect and precocious selection of gait quality, which could be included directly or combined in body indices.

Keywords: body measurement, equine locomotion, genetic correlation, treadmill

- Estimation of **genetic correlations between conformation measurements and biokinematic traits at trot** in order to identify objective selection criteria for locomotion ability.

1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

130 horses

Aged between 4-7 years old

Evaluated at the Laboratory of Equine Performance Control (Vet Faculty of Cordoba, Spain)

13 conformation measurements

+

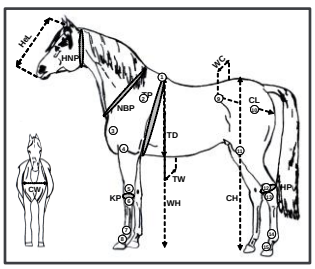
16 biokinematic variables at trot
(4 linear, 6 temporal and 6 angular)

1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

16 Biokinematic traits analyzed

13 Conformation measures analyzed

4 Linear: *forelimb and hindlimb length and forelimb and hindlimb maximum height of hoof.*
6 Temporal: *forelimb and hindlimb duration, forelimb and hindlimb stance phase duration and forelimb and hindlimb swing phase duration.*
6 Angular: *minimal angle of carpus, stifle and tarsus, minimal retraction-protraction angle of hindlimb, maximal retraction-protraction angle of forelimb and maximal angle of pelvis.*



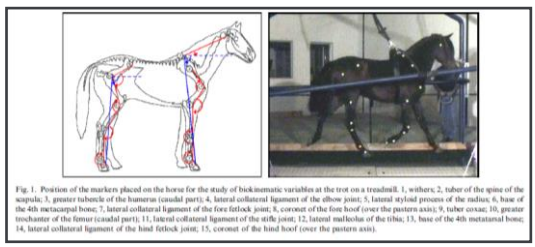


Fig. 1. Position of the markers placed on the horse for the study of biokinematic variables at the trot on a treadmill. 1, withers; 2, tuber of the spine of the scapula; 3, greater tubercle of the humerus (caudal part); 4, lateral collateral ligament of the elbow joint; 5, lateral styloid process of the radius; 6, base of the 4th metacarpal bone; 7, lateral collateral ligament of the fore fetlock joint; 8, coronet of the fore hoof (over the pastern axis); 9, tuber coxae; 10, greater trochanter of the femur (caudal part); 11, lateral collateral ligament of the stifle joint; 12, lateral malleolus of the tibia; 13, base of the 4th metatarsal bone; 14, lateral collateral ligament of the hind fetlock joint; 15, coronet of the hind hoof (over the pastern axis).

Where:
WH is withers height
CH is croup height
CL is croup length
WC is croup width
HNP is head-neck perimeter
TD is thorax depth
NBP is neck-body perimeter
CW is chest width
HeL is head length
HP is hock perimeter
KP is knee perimeter
TP is thorax perimeter
TW is thorax width

1. DESIGN THE PERFORMANCE CONTROL
(SELECTION OF TRAITS)

PROBLEM / OBJECTIVE	PROPOSED SOLUTION
Clear definition of the traits to ensure adequate data collection	Selection of primary traits (related with body measurements) including a reference to body measurement for each class
Inclusion of defects and other traits with direct interest to breeders but with difficult definition (i.e. melanoma, cresty neck, vitiligo...)	Reduction of number of classes for these traits, including a clear definition of them (using pictures, images...)

2. BEGIN THE PERFORMANCE CONTROL
(AT FIELD)

- The Linear Assessment for the main Spanish Horse Breeds includes:

BREED*	PRE	PRMe	PRÁ
N	36,980	702	602
REQUERIMENT	≥ 3 years	≥ 3 years	≥ 3 years
SCALE	1-9	1-7	1-7
PRIMARY	20	19	29
SECONDARY	11	16	19
MOVEMENT	0	9	9
BEHAVIOUR	0	0	1
OTHERS	0	Coat color and quality	0
WHERE**	ST, MC, PT	ST, MC	YHPT

•Breed: PRE is Pura Raza Español, PRMe is Menorca Purebred Horses and PRÁ is Spanish Arab Horses.

•**Where: ST is studs, MC is morphological contests, PT is performance test and YHPT is young horses performance tests.

2. BEGIN THE PERFORMANCE CONTROL
(AT FIELD)

PROBLEM / OBJECTIVE	PROPOSED SOLUTION
No homogeneous conditions for data collection (presentation, light conditions, fatigue...)	Homogenization of conditions for data collection: •Concentration of animals by age, sex… •Standardize presentation for evaluation (angles) •Establish compulsory break times for appraisers •Homogenize environmental conditions (light, season, place...)
Ensure adequate data collection from the beginning	Pre-selection of appraisers to collect data: •Teach a course •Evaluate proposed persons •Select those with higher level •Periodical checking and training of appraisers
Ensure equilibrate number of evaluations by appraisers to obtain adequate evaluation of data collected	Homogeneous distribution of animals between appraisers: •Repeated evaluations by the same appraiser •Evaluation of animals measured for body measurements (primary traits) •Evaluation of the animals by different appraisers

3. TESTING THE PERFORMANCE CONTROL
(EVALUATION OF THE PROCEDURE)

- The evaluation of procedure included different statistical and genetic tests:

Reproducibility: the probability that two appraisers produced the same appraisal for the same trait and the same horse, for horses evaluated by more than one appraiser.

BREED		Range	Average
Pura Raza Español	**PRE**	0.89-0.99	0.94
Menorca Purebred Horses	**PRMe**	0.65-1.00	0.93
Spanish Arab Horses	**PRÁ**	0.57-0.96	0.83

- Evidences **capacity of appraisers** to discern differences between classes within biological scale
- Average values >0.90 in PRE and PRMe horses
- Definition of traits with lower reproducibility has to be reviewed and harmonized to avoid differences
- Appraisers have to work together to improve the procedure and their work at field

3. TESTING THE PERFORMANCE CONTROL
(EVALUATION OF THE APPRAISERS)

- The evaluation of appraisers included different statistical tests:

Repeatability: the probability of awarding the same rating for the same trait and the same horse in two ratings by the same appraiser.

BREED		Range	Average
Pura Raza Español	PRE	0.61-1.00	0.97
Menorca Purebred Horses	PRMe	0.93-1.00	0.98
Spanish Arab Horses	PRÁ	0.56-1.00	0.97

- Evidences the **capacity of appraisers** to repeat a measure for the same animal
- Ranged between 0.56 and 1.00, with acceptable average values (>0.95) in the 3 populations
- Some problems were detected for an appraiser in PRE (min. 0.61) and PRÁ (min. 0.56)
- These appraisers have to be checked periodically and controlled to help them in their function

3. TESTING THE PERFORMANCE CONTROL
(EVALUATION OF THE APPRAISERS)

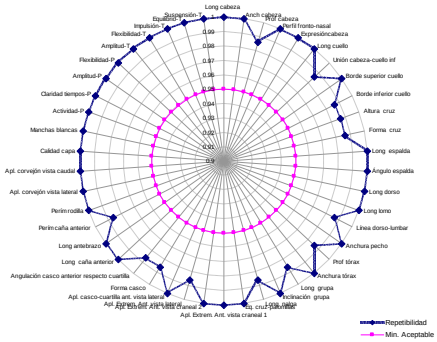
Reliability: Probability that the score given by the appraiser is in accordance with the body measurement, evaluated only for primary traits.

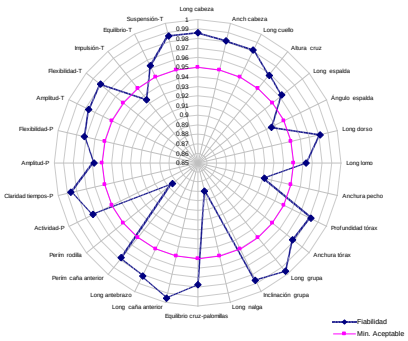
BREED		Range	Average
Pura Raza Español	PRE	0.80-0.98	0.93
Menorca Purebred Horses	PRMe	0.90-0.98	0.94
Spanish Arab Horses	PRÁ	Not available	

- Evidences the **capacity of appraisers** to measure the animal "with their eyes"
- Average values >0.90 in PRE and PRMe
- Adequate results were obtained in general
- Objective definition of the classes for some traits is necessary (using direct body measurement)

3. TESTING THE PERFORMANCE CONTROL
(EVALUATION OF PROCEDURE AND APPRAISERS)

- Each year, procedure and appraisers are evaluated
- All appraisers receive information about the general and personal results of the evaluation, in order to guide their recycling





Repeatability: the probability of awarding the same rating for the same trait and the same horse in two ratings by the same appraiser.

Reliability: Probability that the score given by the appraiser is in accordance with the body measurement (only for primary traits).

3. TESTING THE PERFORMANCE CONTROL
(EVALUATION OF PROCEDURE AND APPRAISERS)

PROBLEM / OBJECTIVE	PROPOSED SOLUTION
Inadequate results for reliability, reproducibility or repeatability	Eliminating appraisers with average values lower than 60% Intensive recycling of appraisers with values between 60-80% Courses for appraisers: •Clarify definition of traits •Detection of critical points •Advice to solve concrete problems Personal reports for each appraiser
Detection of divergence between appraisers	Clarify definition of traits giving more information (pictures, videos, photos...) Reduce subjective traits (secondary), i.e. divide secondary complex traits in different primary traits, selection of primary traits...

4. GENETIC EVALUATION OF LINEAR TRAITS

Livestock Science

Genetic analyses for linear conformation traits in Pura Raza Español horses

M.J. Sánchez, M.D. Gómez, A. Molina, M. Valera

- Estimation of genetic parameters for linear conformation traits in PRE horses and the **analysis of the quality of the information obtained by appraisers** to ensure that it is used appropriately for the genetic evaluation.

4. GENETIC EVALUATION OF LINEAR TRAITS

Frequency	Annually
Number of evaluations	6
h2 of primary traits	0.06-0.35
h2 of secondary traits	0.08-0.23
h2 of movements	0.27-0.32
h2 of other traits	0.08-0.49
Catalogue	Annually

- Genetic evaluation of linear traits in PRE horses is done annually
- Including only a record by horse in the evaluation
- Each year, breeding values are published in a Breeding Catalogue including the estimation of some indexes

GENETIC INDEXES		FORMULA
Head-Neck	**HNI**	$0.50*BV_{\text{head-neck union}} + 0.50*BV_{\text{length of neck}}$
Body	**BI**	$0.20*BV_{\text{height of the withers}} + 0.40*BV_{\text{length of back}} + 0.40*BV_{\text{back-loin line}}$
Forelimb	**FLI**	$0.25*BV_{\text{length of scapula}} + 0.25*BV_{\text{angle of scapula}} + 0.25*BV_{\text{frontal angle of knee}} + 0.25*BV_{\text{lateral angle of knee}}$
Hindlimb	**HLI**	$0.15*BV_{\text{length of croup}} + 0.20*BV_{\text{angle of croup}} + 0.10*BV_{\text{ischium-stifle distance}} + 0.15*BV_{\text{length of leg}} + 0.10*BV_{\text{muscular development}} + 0.15*BV_{\text{posterior direction of hock}} + 0.15*BV_{\text{lateral angle of hock}}$
Global Index for Dressage	**GID**	**0,1*HNI+0,2*BI+0,2*FLI+0,5*HLI**

LIMITATIONS OF LINEAR ASSESSMENT

In the designing of the sheet

1. A **clear definition of traits** is needed to ensure correct data collection by appraisers, mainly for secondary traits.
2. The **number of classes has to be adjusted** to obtain major discrimination, most accurate evaluations and adequate repeatability by appraisers.
3. The **teaching and training of appraisers** is compulsory to obtain adequate data from the beginning.

In the data collection

1. An **excessive number of traits** makes difficult data collection by appraisers and processing by scientists. So, reduction of the number of traits is recommended.
2. The **maximum homogenization of environmental conditions in the presentation** is needed to reduce environmental effects and help appraisers in their work.

In the use of the data

1. Appraisers have to be **periodically tested** to verify that the information is adecuate and the system is correct.
2. If traits have **low number of useful classes** (used by appraisers), they have to be analyzed separately as categorical traits.