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H36-2

Genetic correlations of radiographic health of the limbs with rideability and character in the Warmblood riding horse

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Background

- high level of athletic abilities and performance capacity in the Warmblood horse
  (main focus on dressage and show jumping)

- for maximum performance increasing importance of performance-related traits
  - radiographic health of the limbs
    → durability of the horse
  - rideability and character
    → quality of horse-rider partnership

Objectives

- estimation of genetic parameters for
  a) radiographic health traits and
  b) rideability and character

- genetic evaluation for radiographic findings in the limbs, rideability and character
  → expected response to selection

Data sources

- **radiographic data from the Hanoverian Society (1991-2004)**
- **performance data including rideability and character from mare performance tests (1987-2004)**

$\Rightarrow$ **10720 German Warmblood horses**

- **pedigree data (unified animal ownership database)**

Traits

- radiographic findings in the limbs
  - osseous fragments in fetlock joints (OFF)
  - osseous fragments in hock joints (OFH)
  - deforming arthropathy in hock joints (DAH)
  - distinct radiographic changes in the navicular bones (DNB)
- rideability
  - test rider
  - judge
  - total
- character

Radiographic health traits

Radiographic finding	***Orthopedic disease***
Osseous fragments in fetlock joints (OFF)	mainly Osteochondrosis (Fetlock-OCD) ⊛
Osseous fragments in hock joints (OFH)	Osteochondrosis (Hock-OCD)
Deforming arthropathy in hock joints (DAH)	Bone spavin
Distinct radiographic changes in the navicular bones (DNB)	Navicular disease

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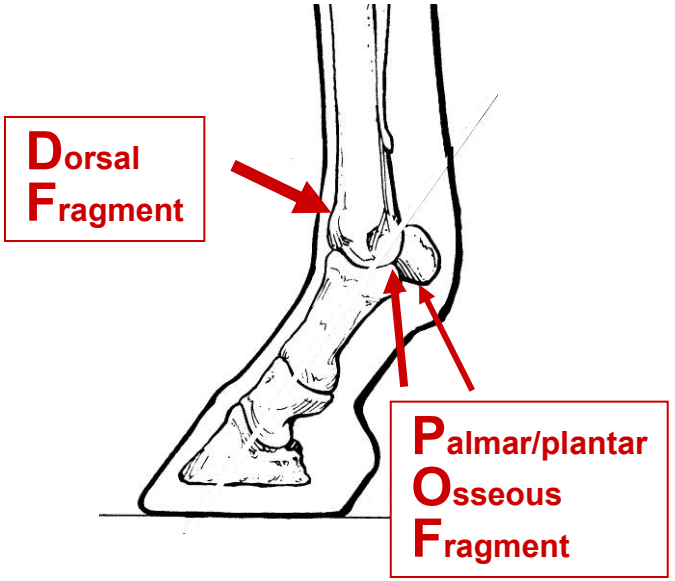

⊛ **subsample of radiographic data (1997-2004): 5579 German Warmblood horses with detailed information on fragment locations within joints**

⇒ **typical OC affection site: dorsal fragments (DF) in 76% of OFF cases**

⇒ **highly positive additive genetic correlation (96%) between DF and fetlock bone associated POF**

[indication of positive additive genetic correlation between DF and sesamoid bone associated POF]

Radiographic data

- **radiographic information on 7950 horses**
- **mostly 3 to 5 years old (mean age 3.97 years)**
- **male to female ratio of 1.2 : 1.0 (4378 ♂, 3572 ♀)**

Radiographic finding	***Prevalence***
Osseous fragments in fetlock joints (OFF)	25.91 %
Osseous fragments in hock joints (OFH)	9.00 %
Deforming arthropathy in hock joints (DAH)	8.44 %
Distinct radiographic changes in the navicular bones (DNB)	19.65 %

Rideability & character data

- **rideability and character scores (scale 1-10) for 2952 horses**
- **mostly 3 to 4 years old (mean age 3.28 years)**

Performance trait	Mean score
Rideability / test rider (rRID)	6.96 ± 1.05
Rideability / judge (jRID)	7.05 ± 0.76
Rideability / total (tRID)	7.01 ± 0.84
Character (CHAR)	7.60 ± 0.57

Distribution of horses

representation of sires in the whole dataset (10,720 horses):

806 sires with on average 13.3 informative offspring (range 1 to 420)

Number of sires	Offspring with radiographic data	Offspring with rideability and character data
453 (56%)	+	+
255 (32%)	+	-
98 (12%)	-	+

Genetic analyses

- **estimation of genetic parameters with REML (VCE)**
  [binary traits: transformation to the liability scale]
- **genetic evaluation using BLUP (PEST)**
  $\rightarrow$ standardization of breeding values to 100 $\pm$ 20 (relative breeding values, RBV)
- **use of multivariate linear animal models with pedigree information on 8 generations**

Radiographic findings

$y_{ipq} = \mu + AUCT_i + a_p + e_{ipq}$ (OFF)

$y_{ijkpq} = \mu + AUCT_i + auctAGE\_SEX_j + SEASON_k + a_p + e_{ipq}$ (OFH, DAH, DNB)

Rideability and character

$y_{nopq} = \mu + perfAGE_n + perfplace\_perfyear_o + a_p + e_{ipq}$ (rRID, jRID, tRID, CHAR)

Heritabilities and genetic correlations

Traits (heritability)	rRID (0.38 ± 0.03)	jRID (0.61 ± 0.04)	tRID (0.29 ± 0.03)	CHAR (0.50 ± 0.03)
OFF (0.14 ± 0.02)	-0.16 ± 0.10	-0.07 ± 0.08	-0.18 ± 0.11	-0.10 ± 0.10
OFH (0.33 ± 0.05)	-0.07 ± 0.08	-0.11 ± 0.08	-0.13 ± 0.10	-0.09 ± 0.07
DAH (0.15 ± 0.03)	-0.21 ± 0.09	-0.21 ± 0.10	-0.26 ± 0.11	-0.20 ± 0.09
DNB (0.26 ± 0.03)	0.27 ± 0.08	0.25 ± 0.07	0.20 ± 0.09	0.27 ± 0.07

Expected response to selection

RBV-based selection in sires (n = 806)

→ selection criteria:

- **radiographic health**
- **rideability & character**
- **radiographic health AND rideability & character**

<u>expected response to selection:</u>

change of prevalences of radiographic findings and change of mean rideability and character scores in offspring of selected sires when compared to offspring of all sires (n = 10,720)

Expected response to selection (results)

relative changes of prevalences and mean scores

Trait	No selection		RAD		R&C		RAD + R&C	
n_{sires} ($n_{offspring}$)	806 (10,720)		348 (4,232)		313 (4,822)		294 (3,814)	
OFF	25.91%	100%	24.37%	-5.9%	26.86%	+3.7%	24.64%	-4.9%
OFH	9.00%	100%	8.93%	-0.8%	9.00%	±0.0%	9.08%	+0.9%
DAH	8.44%	100%	8.42%	-0.2%	8.14%	-3.6%	7.75%	-8.2%
DNB	19.65%	100%	20.70%	+5.3%	19.69%	+0.2%	19.87%	+1.1%
rRID	6.96	100%	7.01	+0.7%	7.03	+1.0%	7.02	+0.9%
jRID	7.05	100%	7.06	+0.1%	7.09	+0.6%	7.05	±0.0%
tRID	7.01	100%	7.04	+0.4%	7.06	+0.7%	7.04	+0.4%
CHAR	7.60	100%	7.61	+0.1%	7.61	+0.1%	7.59	-0.1%

Summary of result

- **expected response to selection:**
  - **relative decrease of prevalences of radiographic findings of up to 8%,**
  - **relative increase of mean scores for rideability and character of up to 1%**
- **selection for radiographic health of the limbs alone**
  → marked and almost general improvement
  exception: DNB (unfavorable additive genetic correlations)
- **selection for radiographic health of the limbs and rideability and character**
  → maximization of the genetic gain
  (reduction of the DNB problem)

Conclusions

- **opportunities for further genetic improvement, particularly with regard to radiographic health traits**
- **recommendation of multivariate genetic evaluation and multiple-trait selection in order to account for additive genetic correlations and maximize the breeding progress for all traits with selection relevance in the Warmblood horse (health, rideability and character, performance, conformation, ...)**

Thank you!