IT Solutions
for Animal Production

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Genetic parameters of clinical and radiological findings of candidate stallions presented for licensing for German Warmblood breeding

Kathrin F. Stock[1], Muriel S. Folgmann[2], Karsten Feige[2], Uta Delling[2]
[1] IT Solutions for Animal Production (vit), Verden (Aller), Germany;
[2] University of Veterinary Medicine Hannover, Clinic for Horses, Hannover, Germany
*E-mail: friederike.katharina.stock@vit.de

Session 8
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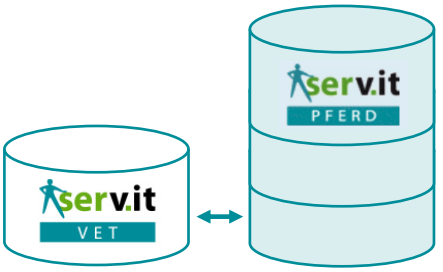
Outline

- background:
  framework for targeting health aspects in breeding programs of horses
- aim and approach of the pilot study
  - standardized screening examinations of candidate stallions (central equine health database)
  - estimation of genetic parameters for radiographic findings in the limbs
- results and discussion
- summary, conclusions, prospects

Health aspects in breeding programs for horses

- durability and health as important factors for sustainable horse breeding
- different focusses of data recording on health aspects
  - observations in foals (monitoring of possible genetic defects)
  - results of standardized examinations of adult horses
- breeding regulations for riding horses in Germany:
  - compulsory examination of stallions
  - phenotypic selection criteria (disqualifying findings)
- facultative screenings, veterinary diagnostics etc.
- ➢ **central equine health data base**



Study framework and approach

- framework
  - central equine health database
  - harmonized screening protocols incl. standardized clinical and radiological examinations
    - all German studbooks for riding horses (FN)
    - valuable sources of information for future genetic and genomic analyses
  - limiting factor: horse sample with available health data
    → candidate stallions as possible starting point (pilot studies)
- aim:
  evaluation of the usability of health data on a preselected horse sample (candidate stallions) for breeding purposes


ORIGINAL ARTICLE | Open Access

Clinical findings of candidate stallions presented for licensing at all German Warmblood horse-breeding associations in 2018–2020

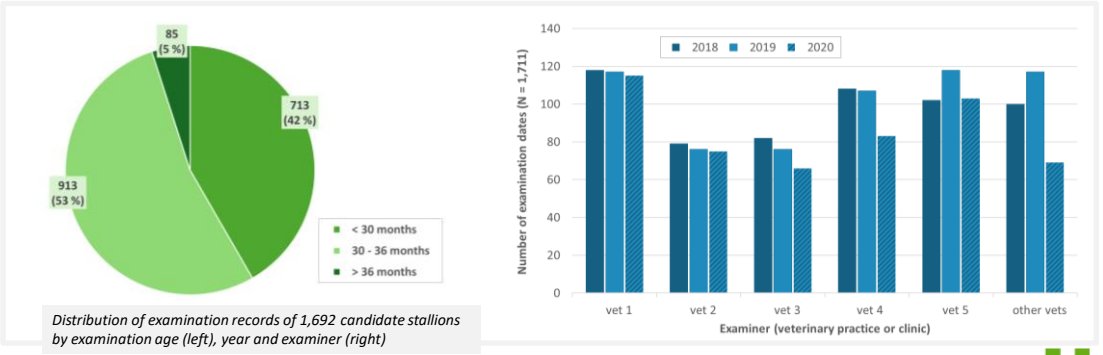
Muriel Sarah Folgmann, Kathrin Friederike Stock, Karsten Feige, Uta Delling

First published: 22 January 2025 | https://doi.org/10.1111/evj.14474

Folgmann et al. (2025b).
Radiographic findings of candidate stallions ...
submitted

Study sample

- phenotypic data
  - examination results of 1,692 stallions presented for licensing at German Warmblood studbooks in 2018 to 2020
  - original records of the responsible veterinarians → central equine health database



Distribution of examination records of 1,692 candidate stallions by examination age (left), year and examiner (right)

Study sample → analyses

- phenotypic data
  - examination results of 1,692 stallions presented for licensing at German Warmblood studbooks in 2018 to 2020
  - original records of the responsible veterinarians → central equine health database
- genetic analyses
  - most commonly recorded clinical findings and radiological findings in the limbs
    - ➢ different levels of grouping vs. refined trait definitions
    - ➢ all horses vs. excluding horses with indicated joint surgery
  - pedigree information on 4 ancestral generations (17,406 horses in the relationship matrix)
  - estimation of variance components in single- and multiple-trait linear animal models (VCE6 software)

$$y_{ijklmn} = \mu + BSeason_i + ExYear_j + ExAge_k + ExVet_l + animal_m + e_{ijklmn}$$

fixed effects: BSeason = season of birth (i=1-5; Nov-Feb, Mar, Apr, May, Jun-Oct), ExYear = year of examination (j=1-3; 2018, 2019, 2020), ExAge = examination age (k=1-3; < 30, 30 - 36, > 36 months), ExVet = examiner (l=1-6; 5+1 veterinary practices / clinics)

Results: clinical findings

Clinical finding	N	prev. [%]	σ_a^2	σ_e^2	h^2	SE_{h^2}
injuries / scars	1,654	11.31	< 0.001	0.100	**< 0.001**	< 0.001
exostosis / swelling / filling (limbs)	1,653	14.16	0.006	0.115	**0.048**	0.037
- FL	1,653	9.07	0.005	0.076	**0.066**	0.043
- HL	1,653	6.35	0.003	0.057	**0.057**	0.050
- cannon / splint bone	1,653	9.80	0.006	0.080	**0.074**	0.046
- cannon / splint bone FL	1,653	7.44	0.006	0.062	**0.089**	0.048
- cannon / splint bone HL	1,653	2.90	0.001	0.027	**0.045**	0.057
respiratory noise	1,653	5.14	0.001	0.044	**0.033**	0.038

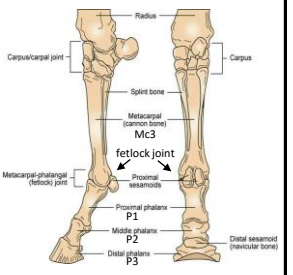
FL = front limbs, HL = hind limbs, prev. = prevalence

- examination protocols indicating presence clinical findings in about half of the stallion → mostly minor findings
- advantages of more specific trait definition
- indications of relevant influence of genetics on the development of 'splints' (FL) → possible relationships with front limb conformation and correctness of movement

Results: radiological findings

Radiological finding	N	prev. [%]	σ_a^2	σ_e^2	h^2	SE_{h^2}
navicular bone - changes of synovial invaginations	1,678	15.20	0.004	0.118	**0.030**	0.042
bone contour P3 - exostosis	1,678	4.41	0.002	0.040	**0.045**	0.039
bone contour P2 - exostosis	1,678	10.55	0.008	0.086	**0.087**	0.042
bone contour P1 - exostosis	1,677	6.56	< 0.001	0.061	**< 0.001**	< 0.001
bone contour Mc/Mt3 proximal - exostosis	1,678	11.44	0.012	0.090	**0.118**	0.052
bone contour Mc/Mt3 distal - indentation	1,678	4.71	0.003	0.041	**0.064**	0.047
fetlock joint - radiopaque body	1,677	14.31	0.012	0.110	**0.096**	0.062
- dorsal	1,677	10.08	0.008	0.083	**0.084**	0.051
- dorsal FL	1,677	6.56	0.003	0.058	**0.056**	0.041
- dorsal HL	1,677	4.35	0.002	0.039	**0.046**	0.042
- palmar / plantar	1,677	4.53	0.002	0.041	**0.050**	0.058
- plantar HL	1,677	4.23	0.001	0.039	**0.032**	0.055
tarsal joint - radiopaque body	1,677	4.35	0.003	0.039	**0.066**	0.059

FL = front limbs, HL = hind limbs, prev. = prevalence



Front limb of the horse (side and rear view).
Modified from Pinterest / C. Cunningham

- remarks in radiological examination protocols of about 70 % of the stallions → mostly minor findings
- estimated genetic parameters partly resembling literature figures (young horse screening, clinic material)

Results: radiological findings II

Radiological finding	N	prev. [%]	σ_a^2	σ_e^2	h^2	SE_{h^2}	N	prev. [%]	h^2	SE_{h^2}
navicular bone - changes of synovial invaginations	1,678	15.20	0.004	0.118	**0.030**	0.042				
distal phalanx (P3) - exostosis	1,678	4.41	0.002	0.040	**0.045**	0.039				
middle phalanx (P2) - exostosis	1,678	10.55	0.008	0.086	**0.087**	0.042				
proximal phalanx (P1) - exostosis	1,677	6.56	< 0.001	0.061	**< 0.001**	< 0.001				
cannon bone (Mc/Mt3), proximal - exostosis	1,678	11.44	0.012	0.090	**0.118**	0.052				
cannon bone (Mc/Mt3), distal - indentation	1,678	4.71	0.003	0.041	**0.064**	0.047				
fetlock joint - radiopaque body	1,605	14.70	0.014	0.111	**0.112**	0.062	1,677	14.31	**0.096**	0.062
- dorsal	1,605	10.34	0.008	0.084	**0.090**	0.054	1,677	10.08	**0.084**	0.051
- dorsal FL	1,605	6.73	0.004	0.059	**0.064**	0.043	1,677	6.56	**0.056**	0.041
- dorsal HL	1,605	4.49	0.001	0.041	**0.032**	0.039	1,677	4.35	**0.046**	0.042
- palmar / plantar	1,605	4.67	0.003	0.042	**0.068**	0.062	1,677	4.53	**0.050**	0.058
- plantar HL	1,605	4.36	0.002	0.040	**0.047**	0.057	1,677	4.23	**0.032**	0.055
tarsal joint - radiopaque body	1,633	4.41	0.003	0.039	**0.068**	0.059	1,677	4.35	**0.066**	0.059

FL = front limbs, HL = hind limbs, prev. = prevalence

excl. horses with indicated joint surgery ($N_{fetlock}$ = 52, N_{tarsus} = 44)

all horses

- impact of data quality (completeness)
  → consideration of examination conditions

Results: radiological findings III

Radiopaque bodies (excl. horses with indicated joint surgery)	fetlock joint - dorsal FL		fetlock joint - dorsal HL		fetlock joint - plantar HL		tarsal joint	
	h^2	SE	h^2 or r_g	SE_{h^2} (SE_{rg})	h^2 or r_g	SE_{h^2} (SE_{rg})	h^2 or r_g	SE_{h^2} (SE_{rg})
fetlock joint - dorsal FL	**0.069**	0.043	0.701	0.284	0.161	0.193	0.350	0.308
fetlock joint - dorsal HL			**0.033**	0.034	0.126	0.326	0.405	0.595
fetlock joint - plantar HL					**0.042**	0.049	0.750	0.671
tarsal joint							**0.059**	0.042

- impact of data quality (completeness)
  → consideration of examination conditions
- limitations of the study sample (data quantity)
  → careful interpretation: possible indications of plausible, previously reported patterns to be confirmed / re-evaluated

Summary & conclusions

- mostly minor clinical and/or radiological findings in young candidate stallions
- few findings with prevalences of > 10%
  - candidate stallions 2018-2020: only two clinical and four radiological findings
  - swellings / exostoses (Mc/Mt, P2), radiopaque bodies (fetlock)
- low heritability estimates for all traits: $h^2 < 0.001$ to 0.089 (clinical) and 0.118 (radiological), with high standard errors (SE ≤ 0.059)
- specific results relating to radiopaque bodies in different limb joint locations
  - plausible patterns of h^2 and r_g (≈ osteochondral fragments)
  - consistent with previously described advantages of considering joint (fetlock, tarsus), limb (front, hind) and location within joint (dorsal, palmar/plantar)

➢ impact of small sample size and preselection

➢ indications of slower, but possible **breeding progress through systematic use of health data** on selection candidates rather than population-wide data

Prospects

- ongoing pilot study on young riding horses intended for auction sale
  - ➢ screening data, lower level of preselection
- possible focus studies (research collaborations)
  - ➢ special diagnostics, advanced understanding of organ systems or certain disorders

➢ continued engagement for increased use of the available infrastructure around the central equine health database
- data recording (user interface serv.it VET)
- data exchange (e.g. veterinary practice software)
- extended data analyses

➢ stepwise development of the required data basis for establishing health traits in genomically supported breeding program of horses

IT Solutions
for Animal Production

contact: PD Dr. Kathrin F. Stock
(E-Mail: friederike.katharina.stock@vit.de ; phone: +49 4231 955623)
*IT Solutions for Animal Production (**vit**)*
Heinrich-Schröder-Weg 1, 27283 Verden, Germany

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Thank you!