Genetic Parameters of Hungarian Sporthorse mares

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Abstract

Mare performance tests for the Hungarian Sporthorse population were evaluated. Data from 1993-2004 were used, covering scores of 435 3-year-old and 240 4-year-old mares. Eighteen subjectively scored traits were considered, that were scored on a 0–10 scale. The animal model for the evaluation of the test results included the fixed test year, age, owner and the random animal and error effects. Variance and covariance components were estimated with VCE-5 software package. Heritabilities ranged from 0.28 (neck) to 0.53 (saddle region) for conformation traits, from 0.29 (jumping style) to 0.52 (jumping ability) for free jumping traits and from 0.22 (walk) to 0.51 (canter and test rider's score) for movement analysis traits. Phenotypic correlations ranged from 0.10 to 0.63 for conformation traits, from 0.20 to 0.82 for free jumping traits and from 0.26 to 0.66 for movement analysis traits. Genetic correlations for conformation traits varied from low to high. For free jumping traits genetic correlations were high. Genetic correlations between movement analysis traits were moderate to high. Positive genetic correlations were found between movement analysis traits and jumping style and jumping ability (0.42–0.87), thus breeding for both characteristics is facilitated.

Keywords: genetic parameters, horse breeding, sport horse, performance test

Introduction

Hungarian Sporthorse is a noble riding and harness horse with an aesthetic and functional conformation. Its primary breeding goal invokes a horse for riding and show-jumping. Beside these targets there are horses suitable for other purposes in the population (MSLT, 2000).

The evaluation of free jumping performance and components of movement analysis could be used for the prediction of the later performance. The importance of free jumping is shown in Hungarian (Ócsag, 1977; Mihók and Jónás, 2005) and foreign (Philipsson, 2005; Santamaria and van Weeren, 2005) publications, respectively. Components of movement analysis are in close connection with future sport performance. Mihók and Jónás (2005) showed that selection for moving ability promoted the best European horse breeds.

Breeding value estimation is based on self performance tests (STP) in Germany and individual performance records are always considered during the evaluation (Kalm 1997). Conformation traits and basic gaits are also evaluated.

Our analysis is based on a collaboration for "4/057/2004 NKFP" researching theme in close cooperation with The Association of Hungarian Horse Breeders and Horse Organization and The Association of Hungarian Sporthorse Breeders (MSLT). The aim of the study is the analysis of the phenotypic relationships between SPT parameters of Hungarian Sporthorse mares. During this work phenotypic and genetic correlations between traits, and heritability of the traits, were determined.

Material and methods

The data set used for the analysis was supplied by MSLT. Test records of 3 and 4 year old mares from 1993 to 2004 were analyzed. There were 435 records from 3-year-old and 240 records from 4-year-old mares, respectively. 79 mares were tested at both ages. Table 1 shows the yearly distribution of the mares in both ages.

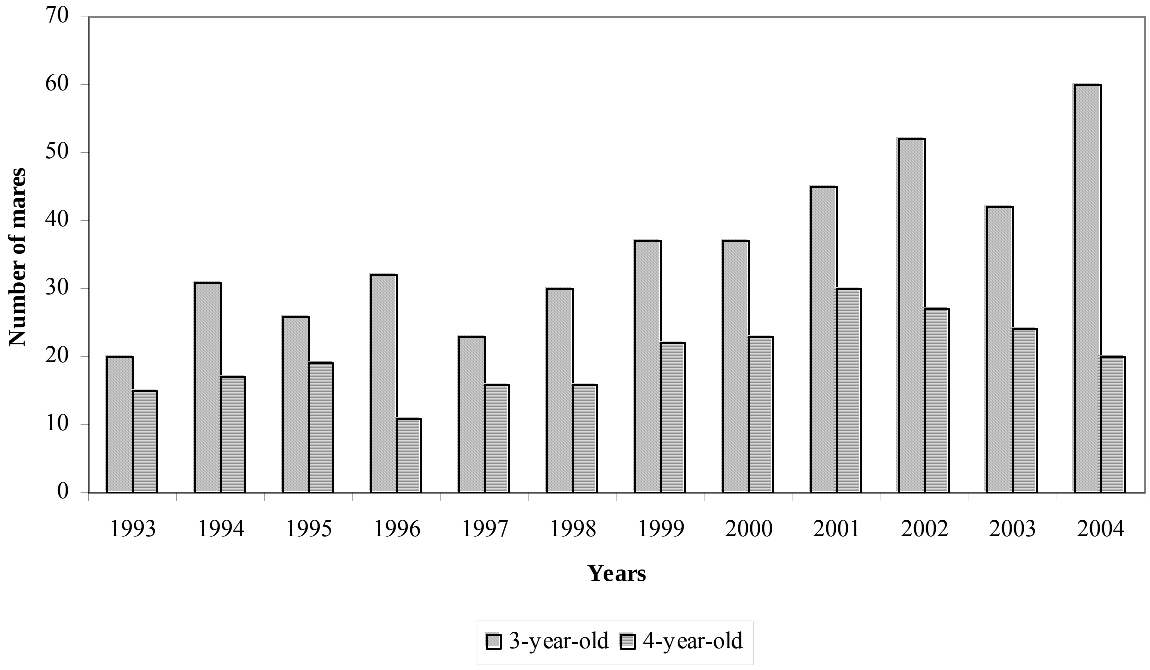

Figure 1.: Distribution of mares participating in the analysis in age-groups

Mare self performance test consists of conformation judgement, free jumping and movement analysis.
Traits judged at mare performance test:
Conformation traits: type, head, neck, saddle region, frame, forelimbs, hind limbs, regulatory of movement, impulsion and elasticity of movement, overall impression.
Free jumping: jumping style, jumping ability–sense of distance; observation during training.
Movement analysis: walk, trot, canter, overall impression, test rider's score.

Scores of free jumping and movement analysis traits are on a 0–10 scale. Conformation traits are judged by weighting the riding horse qualities since 2000. Weighted traits are neck, forelimbs, hind limbs and impulsion and elasticity of movement with scores between 0 and 12. Type (0–6), head (0–8) and frame (0–8) are judged with less weight. Before 2000, the conformation traits were scored in the range of 0 and 10. Analysis was carried out with converting scores of all traits to scores between 0 and 10. Observation during training (one of the free jumping traits) is scored by the trainer based on his impressions during training. Test rider's score given by the test rider based on the ridability of the horse. Other traits are scored by the invited judge. The final score of mare test contains the mean of the conformation score, the mean of free jumping performance scores and the mean of movement analysis scores multiplied by 1, 1.5 and 2, respectively (MSLT, 2000). Judgement committee was the same during evaluated years.

Before estimating the correlation between test results, all phenotypic values were analysed by least-square analysis using the GLM-procedure (SAS, 1999).

The following linear model was applied for the analysis of data from STP of mares:

$$Y_{ijklm} = \mu + Year_i + Age_j + Owner_k + Animal_l + e_{ijklm}$$

where Y_{ijklm} = m–th score of l.-th mare; μ = the population mean; $Year_i$ = effect of mare test's year (1993-2004); Age_j = effect of age class (3, 4); $Owner_k$ = effect of owner; $Animal_l$ = random effect of l-th mare; e_{ijklm} = random residual term.

Variance and covariance components were estimated by the use of VCE-5 (Kovac and Groeneveld, 2003) for each trait. Pedigree used for the analysis contains ancestors of participating mares 2 generations back, containing data of 1368 horses.

Results

The fixed effects of the used animal model were proved to be significant for almost all traits, as Table 1 shows.

Table 1.: Significant levels[1] for traits and fixed effects

Trait	Year	Age	Owner	R^2
Type	***	n. s.	***	0,74
Head	**	n. s.	***	0,46
Neck	***	n. s.	**	0,65
Saddle region	***	n. s.	n. s.	0,54
Frame	***	n. s.	***	0,50
Forelimbs	***	n. s.	*	0,70
Hind limbs	***	n. s.	**	0,66
Regularity of movement	***	n. s.	n. s.	0,71
Impulsion and elasticity of movement	***	n. s.	***	0,67
Overall impression	***	n. s.	***	0,53
Jumping style	n. s.	*	***	0,48
Jumping ability–sense of distance	n. s.	**	***	0,47
Observation during training	n. s.	n. s.	***	0,50
Walk	***	n. s.	***	0,56
Trot	***	n. s.	***	0,51
Canter	***	*	***	0,52
Overall impression	***	n. s.	***	0,54
Test rider's score	***	**	***	0,52

[1] *: $p \leq 0,05$; **: $p \leq 0,01$; ***: $p \leq 0,001$; n. s.: .non significant.

Means and standard deviations for the traits scored in the SPT are given in Table 2. Differences in the number of horses between different trait groups are due to the fact that some horses did not complete all of the tests. Type, head and frame have higher means than other conformation traits in both age-groups.

Table 2.: Number, mean, standard deviation, minimum and maximum values of horses participating in self performance test as 3 and 4 years old

Trait	Number of horses		Mean		Standard deviation		Minimum		Maximum	
	3 year old	4 year old	3 year old	4 year old	3 year old	4 year old	3 year old	4 year old	3 year old	4 year old
Type	410	229	7.87	7.93	1.361	1.395	5	5	10	10
Head	410	229	8.04	8.09	1.265	1.305	4	5	10	10
Neck	410	229	7.17	7.07	0.982	0.945	5	4	10	9
Saddle region	410	229	7.69	7.55	1.179	1.133	4	4	10	10
Frame	410	229	7.90	7.95	1.362	1.335	5	4	10	10
Forelimbs	410	229	7.10	6.93	0.922	0.893	5	4	9	9
Hind limbs	410	229	6.83	6.75	1.009	0.999	3	4	9	9
Regularity of movement	410	229	7.56	7.56	1.057	1.064	4	5	10	10
Impulsion and elasticity of movement	410	229	6.78	6.56	1.217	1.214	3	1	10	9
Overall impression	410	229	7.14	7.03	0.966	0.868	4	5	9	9
Jumping style	398	224	7.01	7.20	0.987	1.136	5	4	10	10
Jumping ability–sense of distance	398	224	6.93	7.29	1.135	1.270	4	4	10	10
Observation during training	398	224	6.88	7.01	0.784	0.813	4	5	9	9
Walk	400	225	6.59	6.56	1.048	1.109	3	4	9	9
Trot	400	225	6.11	6.14	0.889	0.863	3	4	9	8
Canter	400	225	6.58	6.75	1.028	0.950	4	4	10	9
Overall impression	400	225	6.75	6.76	0.866	0.919	4	3	9	9
Test rider's score	400	225	7.17	7.35	1.133	1.169	4	4	10	10

Heritabilities of individual traits were moderate to high as shown in Table 3. Estimated heritabilities were in the range of 0.28 (neck) and 0.53 (saddle region). Close genetic correlations were found among type, head and saddle region classifications. Forelimbs, hind limbs, regularity of movement and the impulsion and elasticity of movement showed low genetic correlations with other conformation traits. Overall impression had moderate and close genetic correlations with scores of other conformation traits. There were moderate phenotypic correlations among conformation traits type, head and neck. Scores of forelimbs, hind limbs, regularity of movement and the impulsion and elasticity of movement showed low phenotypic correlations with other conformation traits. Overall impression – as judgement aspect – with scores of other conformation traits had moderate phenotypic correlations in both ages.

Table 3.: Estimated heritability (diagonal), genetic correlations (upper triangle) and phenotypic correlations (lower triangle) of conformation traits. Standard errors within brackets

Trait		1	2	3	4	5	6	7	8	9	10
1	Type	0.45 (0.06)	0.71 (0.10)	0.58 (0.11)	0.74 (0.09)	0.74 (0.07)	0.59 (0.12)	0.29 (0.13)	0.24 (0.15)	0.38 (0.11)	0.80 (0.07)
2	Head	0.54	0.42 (0.07)	0.31 (0.14)	0.55 (0.09)	0.43 (0.12)	0.60 (0.17)	0.12 (0.14)	0.26 (0.18)	-0.02 (0.13)	0.57 (0.10)
3	Neck	0.42	0.34	0.28 (0.07)	0.71 (0.09)	0.66 (0.12)	0.54 (0.14)	0.17 (0.18)	0.55 (0.17)	0.78 (0.16)	0.89 (0.09)
4	Saddle region	0.47	0.33	0.46	0.53 (0.06)	0.84 (0.09)	0.79 (0.09)	0.43 (0.12)	0.24 (0.14)	0.40 (0.11)	0.89 (0.07)
5	Frame	0.61	0.34	0.41	0.47	0.40 (0.07)	0.76 (0.12)	0.27 (0.14)	0.39 (0.15)	0.50 (0.13)	0.91 (0.10)
6	Forelimbs	0.35	0.23	0.24	0.37	0.35	0.30 (0.08)	0.20 (0.17)	0.49 (0.19)	0.23 (0.14)	0.75 (0.09)
7	Hind limbs	0.27	0.17	0.19	0.21	0.27	0.29	0.35 (0.07)	0.29 (0.17)	0.13 (0.13)	0.66 (0.13)
8	Regularity of movement	0.21	0.12	0.22	0.10	0.25	0.28	0.20	0.32 (0.08)	0.77 (0.10)	0.56 (0.13)
9	Impulsion and elasticity of movement	0.32	0.17	0.36	0.18	0.34	0.19	0.23	0.41	0.43 (0.06)	0.73 (0.08)
10	Overall impression	0.63	0.46	0.57	0.51	0.58	0.49	0.42	0.39	0.62	0.43 (0.07)

Table 4 details free jumping performance parameters. Heritabilities of jumping style and observation during training were 0.29 and 0.32, respectively. Jumping ability–sense of distance had 0.52 heritability. There were high genetic correlations among free jumping traits. Results varied between 0.83 and 0.91. We found high, r=0.82 phenotypic correlation between jumping style and jumping ability–sense of distance. There was low phenotypic correlation between observation during training and other free jumping traits.

Table 4.: Estimated heritabilities (diagonal), genetic (upper triangle) and phenotypic correlations (lower triangle) of free jumping and movement analysis traits. Standard errors within brackets

Trait		1	2	3	4	5	6	7	8
1	Jumping style	0.29 (0.08)	0.99 (0.05)	0.83 (0.14)	0.87 (0.09)	0.74 (0.05)	0.50 (0.03)	0.42 (0.07)	0.55 (0.04)
2	Jumping ability–sense of distance	0.82	0.52 (0.06)	0.83 (0.09)	0.54 (0.04)	0.63 (0.04)	0.53 (0.03)	0.55 (0.04)	0.83 (0.04)
3	Observation during training	0.36	0.44	0.32 (0.07)	-0.06 (0.06)	0.40 (0.06)	0.37 (0.03)	0.78 (0.08)	0.66 (0.03)
4	Walk	0.26	0.20	0.29	0.22 (0.08)	*[1]	0.41 (0.15)	0.56 (0.15)	0.68 (0.16)
5	Trot	0.27	0.28	0.34	0.36	0.36 (0.06)	0.55 (0.09)	0.84 (0.09)	0.64 (0.12)
6	Canter	0.24	0.13	0.19	0.30	0.50	0.51 (0.06)	0.83 (0.07)	0.78 (0.08)

7	Overall impression	0.30	0.45	0.26	0.46	0.54	0.66	0.33 (0.06)	*[1]
8	Test rider's score	0.49	0.53	0.31	0.26	0.31	0.48	0.57	0.51 (0.06)

[1] Optimalization could not be finished in cases marked with *.

Table 4 also shows estimated parameters for movement analysis traits. There were low and moderate phenotypic correlations among movement analysis traits. Canter showed high phenotypic correlation (r=0.66) with overall impression component.

We found low and moderate heritability for movement analysis components. Estimated parameters varied between 0.22 (walk) and 0.51 (canter and test rider's score). There were moderate to close genetic correlations among movement analysis components in the range of 0.41 (walk and canter) and 0.84 (trot and overall impression). Phenotypic correlations among gaits (walk, trot and canter) and free jumping traits are within the range of 0.13–0.34. There were moderate phenotypic correlations between test rider's score and jumping style (r=0.49) and jumping ability–sense of distance (r=0.53), respectively.

Genetic correlations among movement analysis and free jumping components were moderate to high in this study. There was high genetic correlation (r=0.83) between jumping ability–sense of distance and test rider's score.

Discussion

Standard deviations in the cases of type ($s_{3\text{-year-old}}=1.361$, $s_{4\text{-year-old}}=1.395$), head ($s_{3\text{-year-old}}=1.265$, $s_{4\text{-year-old}}=1.305$) and frame ($s_{3\text{-year-old}}=1.179$, $s_{4\text{-year-old}}=1.133$) showed higher differences within the population (Table 3.). This could mean higher heterogeneity in the population traits mentioned above. There were higher means and standard deviations in our study than given by Preisinger et al. (1991) in the Trakehner population. We found lower means for walk, trot and canter than Huizinga et al. (1990). Higher standard deviations were found for walk and canter, but lower standard deviation for trot was found in our research study.

Estimated heritabilities (Table 4.) were higher than that presented by Hartmann (1999) (traits were: type, head, neck, forelimbs, hind limbs) or Nissen (1997) (traits were: type, forelimbs, hind limbs). Hartmann (1999) found similar results for estimating phenotypic correlations as in our study.

For movement analysis traits comparing estimated heritabilities (Table 5), there were similar results for walk ($h^2=0.22$), but greater values for trot and canter than estimated by Huizinga et al. (1990). The heritabilities in this study were similar to the heritability estimates for walk and trot given by Luehrs-Behnke et al. (2002). Gait traits (walk, trot, and canter) showed lower phenotypic correlations than presented by Huizinga et al. (1990) and Uphaus (1993). In the case of movement analysis traits, genetic correlations among walk, trot and canter were lower than estimated by Huizinga et al. (1990) and Luehrs-Behnke et al. (2002).

Conclusion

This study shows medium to high estimates of heritability for traits scored during self performance testing of Hungarian Sporthorse mares. Positive genetic and phenotypic correlations were found between gaits and jumping traits, thus breeding for both characteristics is facilitated. In the following years the results have to be completed with additional mares in order reduce prediction errors.

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