Evaluation of Hungarian Sporthorse mare performance tests

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SUMMARY

Results of the Hungarian Sporthorse mare performance tests were evaluated. Data from the period of 1993-2009 were used, covering scores of 618 3-year-old and 310 4-year-old mares, 109 of them were tested at both ages. Seventeen traits were scored on the tests, which covered ten conformational, three free jumping performance and four movement analyses traits, respectively. Breeding value estimation was based on BLUP animal model. Test year, age and owner were included in the model as fixed effects. Variance components were estimated with VCE-6 software package. Heritabilities ranged from 0.32 (frame) to 0.50 (saddle region) for conformation traits, from 0.39 (jumping style) to 0.49 (jumping ability and jumping skill) for free jumping traits and from 0.20 (walk) to 0.48 (canter) for movement analysis traits. Breeding value indexes were constructed for each trait group. Conformation index was computed based on the weighted scores of the breeding values of conformational traits. The conformational score scales were used as weightings. Free jumping and movement indexes contain the proper breeding values with equal weights. A total index was also constructed using conformation index, two times the free jumping index and two times the movement index. Each breeding values and breeding value indexes were presented with the mean 100 and standard deviation of 20 for the easier understanding.

INTRODUCTION

The BLUP method was used first by Árnason (1980) in horse breeding for Icelandic Toelter horses. Utilization of this method spread very quickly. Tavernier (1988) wrote about the application of BLUP procedures in France and there was some information from the Swedish adaptation in Philipsson's (2005) study. A German breeding estimation method developed by Meinardus (1988) is based on show jumping and dressage results. The results of further German works and developments for estimation methods can be found in Lührs-Behnke et al. (2005) and Velsen-Zerweck – Bruns (1998) studies. Importance of performance tests and possible utilization of its results are also reported by Lewczuk et al. (2004ab).

For the improvement of breeding value estimation in Hungary, the application and correction (if it is necessary) of widely used methods is needed. Preliminary analysis of Hungarian Sporthorse performance data were done by Posta et al. (2007). Our analysis was done in correspondence with The Association of Hungarian Horse Breeders and Horse Organization and The Association of Hungarian Sporthorse Breeders (MSLT). The aims of the study were breeding value estimation and construction of breeding value indexes for the evaluated traits in the performance test of Hungarian Sporthorse mares

MATERIALS AND METHODS

The data set used for the analysis was supplied by MSLT. Test records of three-year-old and four-year-old mares from 1993 to 2009 were analyzed. There were 593 records from 3-year-old and 299 records from 4-year-old mares, respectively. One hundred-nine mares were tested at both ages.

The mare 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; jumping skill.

Movement analysis: walk, trot, canter, overall impression. (MSLT, 2006)

The scores of free jumping and movement analysis traits were scored between 0 and 10. Conformation traits were judged by weighting the riding horse qualities since 2000. Weighted traits (neck, forelimbs, hind limbs and impulsion and elasticity of movement) were scored in a 0–12 scale. Type (0–6), head and frame (0–8) were judged in a smaller interval. Other conformational traits were scored between 0 and 10. All traits were judged by a committee and the horse gets the mean of the scores of the committee members. 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, 2, and 2, respectively (MSLT, 2006).

The pedigree used for the analysis contained ancestors of participating mares at least 2 generations back. Variance components and heritabilities were taken using VCE-6 (Groeneveld et al., 2008) breeding values were estimated with PEST (Groeneveld et al., 1990) for each trait using the following model:

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

where Y_{ijklm} = m–th score of l.-th mare; μ = the population mean; $Year_i$ = effect of mare test's year (1993-2009); 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.

Including the breeder in the model made no significant improvement, so its inclusion was not necessary.

Breeding values were presented with the mean 100 and standard deviation of 20 Koenen [2005] using the formula:

$$EBV_p = 100 + ((EBV_u - mean_u)/\sigma_u)*20,$$

where EBV_p is the estimated BV on the publication scale; EBV_u is the estimated BV on the original scale; meanu is the mean estimated BV on the original scale of the population and σu is the standard deviation of estimated BV on the original scale of the population.

Reliability was computed based on the estimated error variance for every trait in the case of each animal using the following formula:

$$r = \sqrt{1 - PEV/\sigma_a^2},$$

where r is the correlation between the estimated and true genetic value; PEV is the predicted error variance of the breeding value and σ_a^2 is the genetic variance of the measured trait.

RESULTS AND DISCUSSION

Means and standard deviations for the traits scored in the performance test are given in Table 1. 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.

Table 1.

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	593	299	4.80	4.78	0.798	0.822	3	2.4	6	6
Head	593	299	6.34	6.37	0.904	0.949	3.2	4	8	8
Neck	593	299	8.45	8.38	1.185	1.176	6	4.8	12	11
Saddle region	593	299	7.70	7.57	1.087	1.076	4	4	10	10
Frame	593	299	6.33	6.31	0.964	1.066	4	3	9	10
Forelimbs	593	299	8.32	8.18	1.090	1.078	4.8	4.8	11	11
Hind limbs	593	299	7.99	7.91	1.129	1.174	3.6	4.8	11	11
Regularity of movement	593	299	7.49	7.51	1.005	1.012	4	5	10	10
Impulsion and elasticity of movement	593	299	7.92	7.73	1.423	1.370	4	1.2	12	11
Overall impression	593	299	7.20	7.09	0.943	0.908	4.5	5	9.7	9.8
Jumping style	576	295	7.16	7.34	0.993	1.117	4	4	10	10
Jumping ability–sense of distance	576	295	7.23	7.52	1.140	1.251	3.3	4	10	10
Jumping skill	174	62	7.39	7.62	1.095	1.271	4	5	10	10
Walk	578	295	6.86	6.83	0.988	1.038	3	4	9.1	9
Trot	578	295	6.40	6.41	0.842	0.808	3	4	9.1	8.5
Canter	578	295	6.86	6.98	0.958	0.910	4	4	10	9
Overall impression	578	295	6.93	6.97	0.844	0.859	4	3	9.6	9

Table 2.

Estimated heritabilities of traits judged at Hungarian mare performance tests

Trait	h^2	standard error of h^2
Type	0.41	0.08
Head	0.47	0.07
Neck	0.36	0.08
Saddle region	0.50	0.07
Frame	0.32	0.09
Forelimbs	0.32	0.10
Hind limbs	0.33	0.09
Regularity of movement	0.36	0.09
Impulsion and elasticity of movement	0.44	0.07
Overall impression	0.40	0.08
Jumping style	0.39	0.09
Jumping ability–sense of distance	0.49	0.08
Jumping skill	0.49	0.14
Walk	0.20	0.10
Trot	0.34	0.08
Canter	0.48	0.08
Overall impression	0.24	0.08

Heritabilities of individual traits were moderate to high as shown in Table 2. Estimated heritabilities were in the range of 0.32 (neck) and 0.50 (saddle region), 0.39 (jumping style) and 0.49 (both jumping skill and jumping

ability) and 0.20 (walk) and 0.48 (canter) for conformational traits, free jumping traits and movement analysis traits, respectively.

Estimated heritabilities for some conformational traits 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). For movement analysis traits comparing estimated heritabilities (Table 2), 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).

As a result of discussions with sport horse breeders, there was a demand to construct breeding value indexes to sum the estimated breeding values (EBV) of the evaluated traits. A Conformation Index was developed to summarize the EBVs of the ten conformational traits (Figure 1.). As the traits are thought not be equally important for a riding horse, some trait were weighted in the index. The weights of each trait were the same as the maximum point of the trait.

Figure 1.: **Breeding value index of conformational traits**

$$ConfIndex = \left[\frac{\left(\begin{array}{c} 0.6*\frac{Type}{sd} + 0.8*\frac{Head}{sd} + 1.2*\frac{Neck}{sd} + \frac{Saddle\_region}{sd} + \\ 0.8*\frac{Frame}{sd} + 1.2*\frac{Forelimbs}{sd} + 1.2*\frac{Hindlimbs}{sd} + \\ \frac{Reg\_movement}{sd} + 1.2*\frac{Imp\_movement}{sd} + \frac{Overall\_impression}{sd} \end{array} \right) - \mu_{Ind}}{sd_{Ind}} \right] *20 + 100$$

where:

ConfIndex	Conformational Index		
Type	Type	sd =	0.145
Head	Head	sd =	0.204
Neck	Neck	sd =	0.244
Saddle_region	Saddle region	sd =	0.280
Frame	Frame	sd =	0.148
Forelimbs	Forelegs	sd =	0.182
Hindlimbs	Hind legs	sd =	0.208
Reg_movement	Regularity of movement	sd =	0.161
Imp_movement	Impulsion and elasticity of movement	sd =	0.316
Overall_impression	Overall impression – conformation	sd =	0.197
μ_{Ind}	Mean of Conformational Index	av =	0.651
sd_{Ind}	Standard deviation of Conformational Index	sd =	7.198

The four movement analysis traits were scored on the same scale, so they were inserted into the Movement Index with equal weights (Figure 2.).

Figure 2.: **Breeding value index of movement analysis traits**

$$MovementIndex = \left[\frac{\left(\frac{Walk}{sd} + \frac{Trot}{sd} + \frac{Canter}{sd} + \frac{Overall\_impression}{sd} \right) - \mu_{Ind}}{sd_{Ind}} \right] *20 + 100$$

where:

MovementIndex	Movement Analysis Index		
Walk	Walk	sd =	0,103
Trot	Trot	sd =	0,154
Canter	Canter	sd =	0,223
Overall_impression	Overall impression	sd =	0,112
μ_{Ind}	Mean of Movement Analysis Index	av =	0.417
sd_{Ind}	Standard deviation of Movement Analysis Index	sd =	3.225

Figure 3.: **Breeding value index of free jumping traits**

$$FreeJumpingIndex = \left[\frac{\left(\frac{JumpingStyle}{sd} + \frac{JumpingSkill}{sd} + \frac{JumpingAbility}{sd} \right) - \mu_{Ind}}{sd_{Ind}} \right] *20 + 100$$

where:

FreeJumpingIndex	Free Jumping Index		
JumpingStyle	Jumping style	sd =	0,216
JumpingSkill	Jumping skill	sd =	0,287
JumpingAbility	Jumping ability	sd =	0,148
μ_{Ind}	Mean of Free Jumping Index	av =	0.207
sd_{Ind}	Standard deviation of Free Jumping Index	sd =	2.541

Free jumping Index was constructed similarly; the three free jumping performance traits were used with equal weights in the index (Figure 3.). Furthermore, an overall index was also developed based on the three indexes mentioned above. The members of the index were weighted based on the regulation of the Breeder Association (Figure 4.).

Figure 4.: **Overall breeding value index**

$$OverallIndex = \left[\frac{\left(\frac{ConfIndex}{sd} + 2 * \frac{FreeJumpingIndex}{sd} + 2 * \frac{MovementIndex}{sd} \right) - \mu_{Ind}}{sd_{Ind}} \right] * 20 + 100$$

where:

OverallIndex	Overall Index		
ConfIndex	Conformational Index	sd =	7.198
FreeJumpingIndex	Free Jumping Index	sd =	2.541
MovementIndex	Movement Analysis Index	sd =	3.225
μ_{Ind}	Mean of Overall Index	av =	0.512
sd_{Ind}	Standard deviation of Overall Index	sd =	3.854

Each index was presented (similarly to the breeding values) following the Interstallion recommendations (Koenen, 2005) with the mean 100 and standard deviation of 20 (Figure 5.).

Figure 5.: **Breeding values and breeding value indexes of stallion with the most daughters participating in mare performance tests**

2533 Goliath (32 daughters)
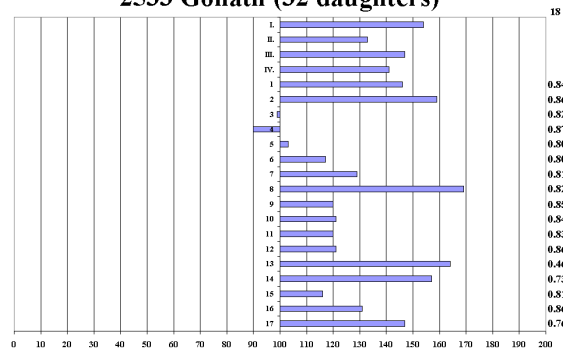
I.: Overall Index, II.: Conformational Index, III.: Free Jumping Index, IV.: Movement Analysis Index, 1: Type, 2: Head, 3: Neck, 4: Saddle region, 5: Frame, 6: Forelimbs, 7: Hindlimbs, 8: Regularity of movement, 9: Impulsion and elasticity of movement, 10: Overall impression, 11: Jumping style, 12: Jumping skill, 13: Jumping ability, 14: Walk, 15: Trot, 16: Canter, 17: Overall impression, 18: Reliability

The reliability of the estimated breeding values is also shown for each trait. The stallion "Goliath" seems to be an overall positive stallion, because its breeding value indexes are more than one standard deviation above the overall mean (100) of the stock. It is important to emphasize that notable progress could be expected in a trait only with the preference of stallions (and offspring of these stallions) whose breeding values approximate to the three standard deviation, but at least one standard deviation greater than the population mean. The reliability values were above 0.7 for almost each trait. 'Jumping ability' was scored only for the last four years this might cause the lower reliability value. To improve the reliability of the estimated breeding values, the evaluation of more offspring would be necessary in the performance tests.

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