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Single-trait and multi-trait prediction of breeding values for show-jumping performance of horses in the Czech Republic

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ABSTRACT

Genetic parameters for show-jumping performance of horses in the Czech Republic were estimated from 483,303 observations of 17,542 horses recorded between 1991 and 2010. The results from events did not have normal distributions. Data were analysed with a least-squares method (GLM/SAS), and genetic parameters were estimated through a Gibbs sampling method. The statistical model included fixed effects for sex, year of the event, level of difficulty of the event and random effects for rider, permanent environment and an additive genetic effect. Six transformations of the data were tested, and the most suitable evaluation was chosen on the basis of lowest residual variance, highest heritability and closest approximation to normal distributions of residuals and breeding values. By these criteria, the best evaluation was accomplished with the shifted Blom-normalised rank for penalty points. For comparison, breeding values were predicted with a single-trait and multi-trait animal model. In the multi-trait model, each record was assigned to one of three traits on the basis of the difficulty of the performance event (i.e., fence height 90–110 cm defined the first trait, 120–135 cm the second trait and 135–150 cm the third trait). The heritability estimates of show-jumping performance were 0.07 for the single-trait model and 0.07, 0.10 and 0.16 for the multi-trait models. Relative breeding values and relative commercial values of the horses were calculated. Both had a normal distribution, and positive genetic trends were estimated for the relative breeding values.

1. Introduction

Jumping performance of sport horses has been evaluated using different kinds of traits and methods. Some studies use financial earnings as the evaluated trait (Langlois and Blouin, 2004), whereas others are more focused on total time, rank or number of penalty points (Janssens et al., 1997). A major disadvantage of most criteria is that only a minor part of the population has recorded performance and thus can be included in the calculations by monetary gains, penalty points or ranking alone (Janssens et al., 1997). For this reason, other studies use gait analysis results or free-jumping performance as the evaluated trait. Although gait analysis can be useful for exclusion of inadequate young horses, genetic correlations between gait characteristics and show-jumping performance are very low (0 to 0.1), with the exception of canter for which the correlations range from 0.16 to 0.39 (Ducro et al., 2007).

Non-normally distributed data are a common problem that is often solved by transformation of the data to the

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normality (Foran et al., 1995) by logarithms (Langlois and Blouin, 2004) or the Blom transformation (Janssens et al., 1997; Posta et al., 2010).

A question that is often discussed is how to take into account differences among events in their difficulty. Janssens et al. (2007) suggests using the ranking of horses in separate competitions. An alternative approach would be utilization of a multi-trait model in which events differing in difficulty are considered to be different traits.

Multi-trait animal model heritability estimates for jumping performance have ranged from 0.03 (Posta et al., 2009) to 0.05 (Quinn, 2005) to 0.09 (Janssens et al., 1997) to 0.29 (Viklund et al., 2011). Predicted breeding values can be transformed to a relative scale, and these values are a common evaluation criterion for the selection of horses belonging to larger breeding associations in many countries.

In the Czech Republic, auxiliary penalty points (APPs) were established as official values for evaluation of sport performance of horses in 1985. The basis of the method is a recalculation matrix which assigns values by taking into account the difficulty of each event. Moreover, the Absolute Sport Values are published for ranking of stallions. Absolute Sport Values are derived from APPs as a weighted mean of number of APPs in all difficulties from all offspring of each individual stallion. No routine evaluation of horses by BLUP, REML or Gibbs sampling methodology is being done in this country at this time.

The aim of the study was to compare penalty points (PPs) and auxiliary penalty points (APPs) as dependent variables for prediction of breeding value of horses using two methods of transformation (i.e., logarithmic and Blom transformation) in single-trait models, then to compare the best dependent variable from single-trait analysis with its multi-trait animal model counterpart based on the difficulty of events. This is the first published analysis of sport horse performance in the Czech Republic by the BLUP method.

2. Materials and methods

The data were recorded by the Czech Equestrian Federation (www.cjf.cz) between 1991 and 2010 and contained 483,303 results of horse show-jumping performances of the Fédération Equestre Internationale table A competitions (Article No 236-238 of Jumping Rules, www.fei.org). Difficulty classifications are defined for 16 distinct events in the Czech Republic, and disqualifications from an event are recorded as 999 penalty points. To create a more appropriate scale, the disqualification values were changed to the value of penalty points equal to 50. The categories of difficulties of events are described in Table 1.

The APPs are calculated from penalty points as described by Czech Equestrian Federation (www.cjf.cz). Depending on the result of the event, the value of the auxiliary penalty points is determined by the value shown in Table 1 at the intersection of disqualification or penalty points and difficulty of the event.

Penalty points (PPs) and auxiliary penalty points (APPs) data both have non-normal distributions. Therefore, logarithmic and Blom transformed (Blom, 1958) data were analysed in addition to the untransformed penalty points data. In total, six dependent variables were analysed, and their characteristics after transformations are shown in Table 2.

For feasibility of log transformation of 0 PPs and more equal impact of the differences in low and high number of penalty points of individuals after transformation, the value 2 was added to all penalty points. To investigate data transformations, SAS software was used (SAS, 2005).

Table 1
Categories of the difficulty of events and determination of the values of auxiliary penalty points from penalty points and event difficulty.

Difficulty	Max. height or range of height of fences	Required no. of fences with max. height	Trait in multi-trait model	Determination of auxiliary penalty point values											
				DQ	Maximal no. of penalty points										
					0	4	9	12	16	20	24	26	32	36	40
T**	150	11	III	−2	22	19	16	14	12	10	8	6	4	2	1
TT	145–155	N/A	III	−2	22	19	16	14	12	10	8	6	4	2	1
T*	150	7	III	−3	19	16	14	12	10	8	6	4	2	1	0
T	150	4	III	−3	19	16	14	12	10	8	6	4	2	1	0
ST**	135–145	N/A	III	−4	12	10	8	6	5	4	3	2	1	0	0
ST	140	7	III	−4	12	10	8	6	5	4	3	2	1	0	0
ST*	140	4	III	−4.5	10	9	8	6	5	4	3	2	0	0	0
S**	125–135	N/A	II	−5	9	8	7	5	4	3	2	1	0	0	0
S	130	7	II	−5	9	8	7	5	4	3	2	1	0	0	0
S*	130	4	II	−5.5	7	6	5	4	3	2	1	0	0	0	0
L**	115–125	N/A	II	−6	6	5	4	3	2	1	0	0	0	0	0
L	120	7	II	−6	6	5	4	3	2	1	0	0	0	0	0
L*	120	4	II	−6	6	5	4	3	2	0	0	0	0	0	0
ZL	110	5	I	−5	5	4	3	2	1	0	0	0	0	0	0
Z	100	5	I	−4	4	3	2	1	0	0	0	0	0	0	0
ZM	90	4	I	−3	3	2	1	0	0	0	0	0	0	0	0

DQ—Disqualification; Few examples of APP calculation: If the result of a horse in T* difficulty is 16 penalty points then his number of APPs is equal to 10 as is stated in T* row and maximal no. of 16 PPs column. In the same manner horse with 1 PP in L** difficulty gains 5 APPs (max. no. 4 column of the table). Disqualification in S** difficulty results in −5 APPs (S** row and column named disqualification). Therefore better result in the event and higher difficulty of event will cause higher number of APPs.