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GENETIC PARAMETERS FOR COMPETITION TRAITS AT DIFFERENT AGES OF SWEDISH RIDING HORSES

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Abstract
In Sweden competition results have been made available for research since the beginning of 1960'ies. Until 2002 results for approximately 38,000 horses were available from dressage, show jumping and eventing competitions. Genetic parameters were estimated for results obtained at different stages in life of the horses. The results were divided in three groups. The first group included results up to six years of age, the second up to nine years and the last included all results the horses had until 2002, i.e. lifetime results. A multi-trait animal model was used for estimation of genetic parameters for traits in dressage and show jumping. Heritabilities were higher for show jumping than for dressage and increased with increasing of age of the horses and amount of information. For dressage heritabilities increased from 0.08-0.10 for the youngest group to 0.15-0.16 for the lifetime results. For show jumping the corresponding values increased from 0.11-0.20 to 0.23-0.38. Genetic correlations between different age groups were high (0.94-1.00). Results from this study show that lifetime results are more accurate to use for genetic evaluations than results achieved at six years of age, but correlations between the results at six years and the accumulated lifetime results are high. It is suggested that lifetime results from competitions should be integrated into the genetic evaluation system.

Introduction
Breeding values for Swedish riding horses are estimated with the BLUP method. Today, indexes are based on results from the Riding Horse Quality Test (RHQT), which is a field test for four year old horses where they are judged for conformation, health, gaits and jumping ability. However, the goal is to develop integrated breeding values including results from competition, RHQT and a field test for three year old horses. As a step in that direction, genetic parameters for competition results at different stages in life of the horses were estimated.

The breeding goal for Swedish Warmblood horses aims at horses which are internationally competitive in dressage and show jumping. In Sweden, horses can start to compete at the age of four, but higher classes in competition are not reached until several years later. Therefore, it is of interest to know if later competition results can be replaced with results from young horses in genetic evaluations of riding horses. The objective of the present study was to examine how well young horse performances agree with

performances later in life. Another aspect was to se if competition data are suitable to use for genetic evaluations of horses.

Material

Data were available on results from riding horse competitions in Sweden since 1961. Until 2002 there were records from 38112 horses which had competed in dressage, show jumping or eventing. Because of the low amount of participated horses in eventing only results from dressage and show jumping were considered in this study. Most of the horses had competed in show jumping, in total 23771 horses with competition results, while 10761 horses had competition results in dressage. The results for each discipline were divided into three different groups depending on age of the horses. The first group included results up to six years of age, the second group results up to nine years of age, and the last included all results, so called lifetime results. In table 1, the number of horses in each group are shown. Because accumulative results are used, competition results up to six years of age are included in the other two age groups and competition results up to nine years are included in lifetime results.

Tabel 1. Number of horses within age group with results in competitions

	Dressage	Show jumping
Up to six years	3864	11642
Up to nine years	8290	19969
Lifetime	10761	23771

In Sweden, competing horses accumulate points as a result of the performance in each competition. In this study, those points as well as number of placings were used in the genetic study. As a supplement of the two traits the quota between them (points per placing) was also used to indicate at what level the horses had competed.

Methods

Because the results were accumulated the distribution was skew and the traits needed to be transformed. After testing different methods of transformation it was found that transformation with 10-logarithm was the most suitable method for this dataset.

A restricted maximum likelihood (REML) procedure of the DMU package (Madsen & Jensen, 2000) was used to estimate variance components with a multiple trait animal model. The following model was used for all traits:

$$Y_{ijk} = \mu + sex_i + birth\ year_j + animal_k + e_{ijk}$$

where Y_{ijk} is the observation of each trait for k^{th} horse; μ is the population mean; sex_i is the fixed effect of i^{th} sex; $birth\ year_j$ is the fixed effect of j^{th} birth year; $animal_k$ is the additive genetic effect of k^{th} horse and e_{ijk} is the random residual effect.

Results and Discussion

In table 2, estimated heritablitities for dressage traits are shown. Heritabilities for all traits in all age groups were low, between 0.08 and 0.16. The estimated heritabilities for show

jumping were low to moderately high, between 0.11 and 0.38. Table 3 contains heritabilities for show jumping. Heritabilities for the trait points per placing in the age groups up to nine years and lifetime in show jumping are remarkably high (0.33 and 0.38 respectively). This might be due to the reason that some horses collect a large amount of points during the life by just competing in many competitions, whereas the quota may better indicate the genetic potential of the horse.

For all traits in both disciplines heritabilities increased with an increasing age. This agrees with the literature for show jumping, but not for dressage, where heritabilities decreased with an increasing age (Bruns, 1981; Huizinga & van der Meij, 1989). The reason why higher heritabilities were estimated when older horses were included may be due to adding more information and testing the performance at higher level.

As in this study, higher heritabilities are often estimated for show jumping than for dressage (Bruns, 1981; Huizinga & van der Meij, 1989; van Veldhuizen, 1997; Wallin *et al*, 2003). One exception was Bruns (1981) who estimated higher heritability for dressage than for show jumping in the age group up to eight years. In the age group older than eight years heritability for show jumping was again the highest.

Table 2. Heritabilities for traits in dressage competition

Trait	Up to six years	Up to nine years	Lifetime
Log (number of placings)	0.08	0.15	0.15
Log (number of points)	0.10	0.16	0.16
Log (points/placing)	0.09	0.12	0.15

Table 3. Heritabilities for traits in show jumping competition

Trait	Up to six years	Up to nine years	Lifetime
Log (number of placings)	0.19	0.23	0.23
Log (number of points)	0.20	0.28	0.28
Log (points/placing)	0.11	0.33	0.38

Genetic correlations between age groups were similar for dressage and show jumping. Very high correlations between all age groups (0.94-1.00), tables 4 and 5, indicate that competition results for young horses can be used instead of results from adult horses in e.g. genetic evaluations. In several other studies, reasonably high genetic correlations have been estimated between competition results for young horses with those later in life. Tavernier (1992) estimated moderate to high genetic correlations for show jumping traits between different ages, while Brockman & Bruns (1997) found a high correlation between young horse competition (Dressurpferdeprüfung) and high class competition in dressage. Also van Veldhuizen (1997), estimated genetic correlations for dressage traits in competition and found medium high to high correlations between different ages. When accumulative performances were used for age groups up to four years, up to five years and up to six years in dressage and show jumping, high genetic correlations were estimated (Huizinga & van der Meij, 1989).

Table 4. Genetic correlations between age groups in dressage

	Log (placings)	Log (points)	Log (points/placing)
Up to 6 years-Up to 9 years	0.94	0.95	0.95
Up to 6 years-Lifetime	0.95	0.96	0.96
Up to 9 years-Lifetime	0.98	0.99	1.00

Table 5. Genetic correlations between age groups in show jumping

	Log (placings)	Log (points)	Log (points/placing)
Up to 6 years-Up to 9 years	0.97	0.98	0.99
Up to 6 years-Lifetime	0.95	0.97	0.99
Up to 9 years-Lifetime	0.99	1.00	1.00

Genetic correlations between different measures used (log (placings), log (points) and log (points/placing)) were high (0.70-0.97) and equal for both disciplines. The correlations between log (points/placing) and the other two measures were somewhat lower (0.70-0.88) than between log (placings) and log (points) (0.97). This can be explained by the fact that points/placing rather is a measure on what level horses are competing, while points and placings in many cases tell us for how long period of time the horses had competed.

Conclusions

Even though genetic correlations between young horse performances and lifetime results are high, lifetime results are recommended to be used in the genetic evaluation in the future. The reason is the higher heritabilities estimated when all competition results were included compared with only results from young horses. Because accumulated performances are used, competition results will be available as soon as the horses start to compete. The accuracy will however increase when information from more years is added. Due to preselection of horses, integrated breeding values with results from young horse tests and competition results are preferable to indexes only including competition results.

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