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Testing young Swedish riding horses for sport and for genetic evaluations

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Abstract
In order to get information on young horses to be selected for sport and for genetic evaluations according to more specialized sport breeding objectives, a system for testing Swedish Warmblood horses has been set up. A one day field test for 4-year old riding horses of both sexes was introduced in 1973. The test includes assessment of health, conformation, gaits under rider, jumping ability and temperament. To date nearly 17,000 horses have been tested. The information is used for genetic evaluations based on a BLUP Animal model, which was adopted in 1986. Genetic analyses show moderate heritabilities (0.15-0.35) for conformation and performance traits, and high genetic correlations (0.7-0.9) with competition results at mature age. Based on the experiences of this test the performance tests for stallions were modernized and expanded during the 1980-ies. A simplified one day performance field test for 3-year old horses was developed in the late 1990-ies. Today about half of all young horses are tested at either 3 or 4 years of age. Analyses show that large genetic progress has been achieved. Present activities aim at integrating all sport horse information into the genetic evaluations.

Introduction

The Swedish Warmblood breed has undergone a radical change in Sweden in the last 3-4 decades. Along the increasing interest among young people for riding a new and expanding market for riding horses was opened. As a consequence the number of covered warmblood mares increased at a fast rate. Many mares previously used in the cavalry were used to produce sport horses with quite variable success. In the early 1970-ies only 2,000 mares were covered. After some fluctuations, with a peak of 8,000 mares covered in 1990 the annual number has stabilized at about 5,000 mares being covered by about 200 licensed stallions. This amounts to about 5% of the European Warmblood sport horse breeding population. More than 85% of the mares are artificially bred, and AI based on shipped semen is the most common method used. There is an international exchange, mainly with stallions, both live animals and imported semen. Over 70% of the mares are covered by foreign born stallions.

The other radical change of the Swedish Warmblood breed concerned the request by sports people for horses better adapted to the various sports disciplines. Admittedly Swedish horses had been quite successful internationally for generations in dressage and eventing, but showjumping horses had no success, and it was this discipline that showed most expansion among Swedish riders. Thus, it was needed to redefine the breeding objectives and to develop testing systems that were in alignment with the new breeding goal. In close collaboration

between representatives of the local breeder´s organizations, trainers and scientists at SLU a programme for development of a new testing system of young horses started in 1973. The animal insurance company AGRIA played an instrumental role in supporting this development among its customers. This was a necessity as it was not obvious among conservative breeders and their organizations that a major change in testing and selection procedures had to take place.

The philosophy of developing a young horse testing system was to achieve a number of different goals that would be attractive to both breeders and sports people, for immediate as well as long term benefits, and which also promoted a good horsemanship. In the following some further steps of that development are described together with results from analyses of data collected, and how the results are used in practice.

Young horse testing system goals

The objectives of the young horse testing system designed were in summary to provide:

- a system to find talented horses for the sport
- a system for promotion of a sound training of young horses to be durable
- a regular health control of young horses
- data for research on young horses
- a basis for genetic evaluation of stallions and mares
- information to be used at sale or insurances of young horses

In order to start this program courses were arranged for trainers and veterinarians to be the judges. Together with scientists protocols were developed for the performance and health tests, and all data were computerized. A drawback at that time was that no unique system for numbering or registration of horses was applied. This had to be done in an alternative way until official registration numbers were put in practice in 1980. The lack of unique numbering systems has been a constraint in all data analyses since you must make use of some 20-40 years of data if you are going to handle 2-4 generations of horse data.

Broad breeding objectives….

The breeding objective for the Swedish Warmblood horse population today is to produce durable and noble sport horses at the international level in dressage and showjumping. A second priority is to produce horses for eventing and driving, as well as for general leisure purposes. The rationale behind this broad breeding objective is that riding is one of the most common sport activities among young people in Sweden, and that it should be affordable and easy to get a horse. Thus, it is important that Swedish breeders can provide horses which the market requests. Among the horses used for the equine sport in Sweden about 75% are used for showjumping, 40% for dressage and 10% for eventing, thus 25% of the horses participate in more than one discipline.

…. but also for top sport

Having a small population but international goals may be considered optimistic. Nevertheless, it should be an achievable goal if resources are used efficiently and a wise testing and use of the very best horses are practiced, keeping an open mind also on where to find the very best stallions, according to our breeding objectives, independent of country or studbook of origin.

An overall test of 4-year-olds for sport and breeding

The broad use of horses and subsequent breeding objective required the young horse testing to include horses before they were starting to compete, and thus selected for one of the two major disciplines. At the same time the horses should be old enough to be evaluated under rider. Because of the generally long generation intervals, and as the majority of sport results at the international level are achieved at 8-14 years of age, the importance of utilizing early tests of horses for selection of stallions and mares is further emphasized. With this in mind our young horse testing program, Riding Horse Quality Tests (RHQT), was designed as a one day field test of 4-year old horses of both sexes. Selection of horses for breeding purposes was anticipated to take place among mares with good test results, and by utilizing the data for progeny testing of stallions. Later on this objective has been expanded to include all horses to be genetically evaluated. To be an effective test as many horses as possible of each year of birth should be judged. That means that the tests must be designed to be simple enough for the majority of experienced riders to participate. Over the years 15-30% of the 4-year-olds have participated in the tests. The data base now contains test results for about 17,000 horses, some of which have tested horses for 3-5 generations in their pedigrees.

The purpose of the test was to have an overall assessment of the qualities of the horse at a time when it is broken, but before its competition career had started. The aim was to give independent advice on the suitability of the horse for different sport disciplines, and what to look for when training the horse including its health status.

The tests have evolved over time and presently include judging of the following moments:

- Orthopaedic and medical health incl. a flexion test
- Conformation
- Basic gaits and rideability
- Jumping (under rider or free jumping)
- Temperament/behaviour

All moments of judging (scale 1-10) are compulsory to avoid effects of selection of horses evaluated for dressage vs. jumping purposes. The free choice of jumping test satisfies both showjumping riders and those more interested in dressage, which often prefer free jumping. By including a health test it is possible to prevent horses from being trained too much or taken for competition too early. It also allows horse owners to insure healthy horses for increased values at a lower fee.

BLUP Animal Model since 1986 for selection

Based on the RHQT data a model for genetic evaluations was developed and a BLUP Animal model was adopted already in 1986 (Árnason, 1987). Analyses of data showed that heritabilities for all recorded traits were reasonably high, 0.15-0.35, suggesting that genetic progress was possible by applying selection among tested mares and among stallions after progeny testing. BLUP-values for mares were first published in 1998 (Philipsson, 1998). The BLUP-model is simple but adjusts for the effects of event, birth year and sex of the horse.

The major advantages of using the RHQT compared to competition data for genetic evaluations are that it is based on much less selected data including many more horses, show higher heritabilities, and provide reliable breeding values of both stallions and mares much earlier, contributing to shorter generation intervals. The disadvantage is that selection is based

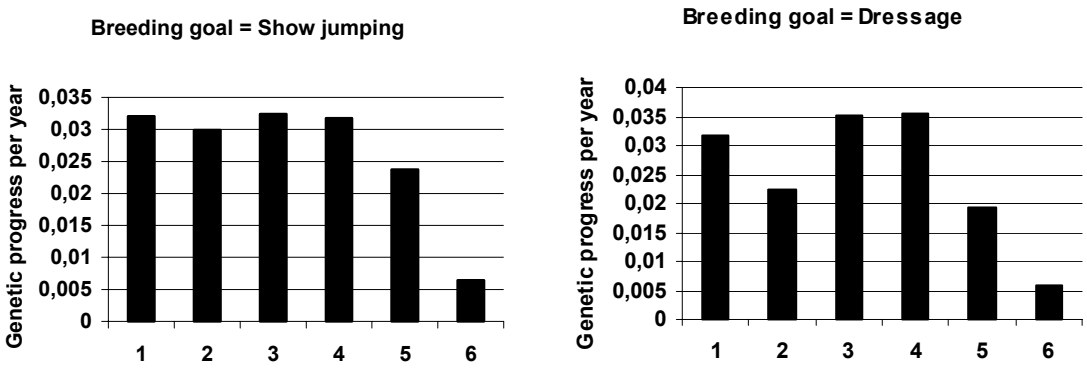
on an indirect trait rather than on competitions results at advanced levels. However, the high genetic relationships between RHQT results and competition results mentioned above, indicate the strong influence selection based on test results of young horses may have on final competition performance.

RHQT and longevity

Data from RHQT has been used to estimate longevity for Swedish riding horses (Wallin, 2001). There were significant phenotypic relationships between the RHQT traits, judged early in horses' lives, and longevity. Orthopaedic status had the greatest influence on longevity, showing the importance to include health recording in young sport horse tests. Horses with an orthopaedic score of nine or ten, on a scale from 1 to 10, had about half the likelihood of being culled early than did horses scoring below six. For the traits conformation and correctness of legs, lowest-scoring horses were twice as likely to be culled early as the highest-scoring horses. Horses with good conformation are assumed to be sound and perform better compared with horses with unfavourable conformation. Both low scores (≤ 5) and high scores ≥ 9) in jumping gave higher risk ratios of being culled compared with averagely scored horses. Highly scored horses were used largely in sport, and were used quite extensively, which may explain the higher risk for the highest-scored horses. The results pointed out the possibility of using traits scored early in a horse's life as predictors of survival and for preventive medicine purposes.

Optimum testing system for mares

To achieve maximum genetic progress the time of selection of mares is crucial. In a simulation study, genetic progress per year was calculated when selecting mares at different ages. To optimize the genetic progress it is important with a high accuracy in selection, short generation interval and a high intensity in selection. If mares are selected after their competition career, the accuracy is high but the generation interval becomes too long and the selection intensity too low to make any progress. The study showed that the highest gain in genetic progress was achieved when selecting mares at the age of three or four (Figure 1). The results from the study also pointed out the importance of testing as many mares as possible. If the mares do not come to the young horse tests, it is impossible to select the best 30-40% of the mares early enough, and the genetic progress will be slow.



1=Test 3-year-olds spring, 2=Test 3-year-olds autumn, 3=RHQT 4-year-olds spring, 4=RHQT 4-year-olds autumn, 5=Competition 6-year-olds 6=Competition 10-year-olds

Figure 1. Genetic progress per year when selecting mares at different ages (from simulation study).

Half of all young horses tested

Based on the results above a special test was introduced in 1999 for 3-year-olds in early spring, before the breeding season. This test replaced the traditional conformation summer show, which did not longer correspond to the demands of the market, nor was it a suitable tool in breeding modern sport horses. The aims with this test are to provide an opportunity to earlier genetic evaluations of stallions and mares, early selection of mares, find talented horses for competition and to encourage early handling of young horses. The traits scored are conformation, gaits at hand and free, and free jumping. Showing the horse ridden is encouraged and is required for the Diploma certificate. However, the gaits under rider are not judged at this stage. About one-third of the horses born each year participate in this test. This means that about half of all young horses available each year are judged at a young horse test, and provides excellent data for genetic analyses and estimation of breeding values of both stallions and mares.

Genetic analyses were done after the first four years of testing three-year-old horses. During 1999-2003 over 4,000 horses had participated. The heritabilities for traits judged in the 3-year-old test were slightly higher than the corresponding traits scored in RHQT (Tables 1 and 2). This may be explained by that horses are younger than horses participating in RHQT and therefore less influenced by training and rider. High genetic correlations were estimated between corresponding traits in both tests (Table 3). Therefore, it can be assumed that largely the same gene complex affects the traits in the two different tests, although they are judged differently.

Table 1. Heritabilities for traits judged in RHQT

Trait	**Heritability**
Conformation traits[1]	0.28-0.37
Correctness of legs	0.10
Gaits under rider	0.34-0.44
Temperament for gaits under rider	0.31
Jumping, technique and ability	0.21
Jumping, temperament	0.15

[1] Except legs

Table 2. Heritabilities for traits judged in young horse test for 3-year-olds

Trait	**Heritability**
Conformation traits[1]	0.30-0.47
Correctness of legs	0.09
Gaits at hand	0.37-0.45
Free jumping, technique and ability	0.33
Free jumping, temperament	0.22

[1] Except legs

Table 3. Genetic correlations estimated between traits tested at 3 and 4 years of age

Trait at 3-year-old test	Trait at RHQT	Genetic correlation
Conformation traits[1]	Conformation traits[1]	0.94-0-98
Correctness of legs	Correctness of legs	0.81
Gaits at hand	Gaits under rider	0.83-0.94
Free jumping, tech. & ability	Jumping, tech. & ability	0.96
Temperament for jumping	Temperament for jumping	0.97

[1] Except legs

Performance testing of stallions

Based on the experiences from the first 3-4 years of young horse testing, and of 100 day testing of stallions in other countries, we designed in the late seventies our own performance test for potential breeding stallions. It included initially 4-5-year old stallions. The same tests were performed as those described above but at more advanced levels and repeatedly during 8 days. The number of stallions tested per year expanded from less than 10 to about 50. In all tests it has been the responsibility of the stallion owner to provide the training and show of the horse. The exception is the rideability test of the stallions for which test riders are used. Top judges of our national teams of trainers or coaches have been used as judges, often with foreign guest judges as advisors to bring in international views. An interesting observation is that most stallions have been trained and shown by riders belonging to our national elite allowing the stallion to show their full potential in the tests.

Intense selection among stallions on performance

An increasingly strong selection of stallions has been applied. In the past 15 years on average only one-third of the stallions have been approved for breeding after the performance test among those already being qualified from a conformation and veterinary point of view. Genetic analyses show moderate to high heritabilities for all traits, 0.3-0.5, and very high genetic correlations with corresponding traits at RHQT (Table 4) (Gerber Olsson et al., 2000). Many of the active breeding stallions continue to compete after the test. A high proportion of these stallions have been successful at advanced competition levels. Over the years our national teams in both dressage and jumping have included many active breeding stallions. The genetic correlations between traits judged at stallion performance test and competition at mature age are moderate to high according to Gelinder et al. (2001), see table 5.

Table 4. Heritabilities for traits judged at stallion performance test
(Gerber Olsson et al., 2000)

Trait	Heritability
Gaits under rider	0.37-0.46
Free jumping, technique and ability	0.47
Free jumping, temperament	0.23
Jumping, technique and ability	0.32
Jumping, temperament	0.33

Table 5. Genetic correlations estimated between traits tested in the stallion performance test and competition performance (Gelinder et al., 2001)

Trait in stallion performance test	Competition trait
	Dressage
Walk	0.20-0.24
Trot	0.57-0.66
Canter	0.26-0.29
	Show jumping
Free jumping	0.74-0.75
Jumping under rider	0.87-0.88

Recent developments has led to inclusion of also 3-year old stallions for a less advanced test, but which has to be followed by another approved test at 4 years to keep the breeding license. Also stallions are tested more thoroughly for one or both of the disciplines, jumping and dressage, to be approved. It means that a stallion must show very special talents in at least one of the disciplines to be approved for breeding.

Comprehensive data base on competition results

Ever since the early seventies competition data has been computerized. Presently about 40,000 horses are included. Genetic analyses have shown about twice as high heritabilities for lifetime performance, measured as accumulated points received at all competitions and where the level of competitions are considered, as for results at 6 years of age. However, the genetic correlations are high between the different age groups. In general the heritabilities of lifetime performance are comparatively high, 0.15 for dressage and 0.27 for showjumping (Wikström, 2004). Genetic analyses of relationships between competition results at mature age and RHQT results show high correlations, around 0.9 for show jumping and 0.75 for dressage related traits.

Integrated indexes under development

The present research aims at integrating the results from the test of 3-year-olds and the competition data into the BLUP-index system. When results from tests of 3- and 4-year-olds are included the effects of selected data from competitions are reduced. In constructing the indexes it is important to note that the initially described breeding objective is kept, i.e. competition results at advanced levels in dressage and show jumping respectively. The young horse test results are used as indicator traits. Preliminary results show overall rather similar indexes as previously, but in some instances clear differences are shown, indicating that some horses do well as young, but do not develop as well at more advanced levels. In Table 6 ranking of dressage stallions by BLUP index is presented as an example when only RHQT, and both RHQT and competition results have been used in the genetic analysis. It is considered important to make use of all data sources in order to both get as reliable proofs as possible and for the credibility of the indexes among breeders, trainers and riders.

Table 6. Ranking of dressage stallions by BLUP index based on different information (GP = the stallion has placings in Grand Prix dressage)

BLUP based on 4-year-olds (RHQT)		**BLUP based on RHQT and Competition**	
Master	GP	Chagall	
Amiral	GP	Chapman	GP
Bernstein		Bernstein	
Chapman	GP	Amiral	GP
Briar	GP	Briar	GP
Good Future		Master	GP
Bayron		Portwein	
Nactus		Zorn	GP
Midt-West Ibi-Light	GP	Nocturne	
Napoleon		Good Future	
Cavalotti		Iran	
Guinness	GP	Bayron	
Zorn	GP	Highlight	
Chirac	GP	Chirac	GP
Chagall		Gaspari	GP
Beach Boy		Gauguin de Lully	GP

Increased genetic progress

BLUP-analyses of the RHQT data provide information on the genetic progress made over the years. The graph (Figure 2) shows that the progress made among horses born up to 1985 were quite modest, whereas the annual progress after that is substantial in all disciplines. The change in rate of progress coincides very well with the effects of intensified selection of stallions from own performance tests and later complemented by culling of stallions based on BLUP-indexes. But larger genetic progress could be made if even more stallions were tested at the stallion performance test, and more strict criteria for culling old or not so successful stallions were applied. Considering the selection of mares, much can be done to increase the genetic progress. The mares should be tested at young horse tests, and only the best 30-40% should be used in breeding. It is important that the breeders can get objective breeding advice and that the breeding organizations encourage breeding with excellent mares. Recently an internet based system for information on test results and BLUP-indexes of stallions, mares and young horses has been developed by Àrnason (IHBC, 2005) in collaboration with the Swedish Warmblood Association and SLU. Present research and development activities require increased efforts to inform breeders about the genetic tools available for their breeding.

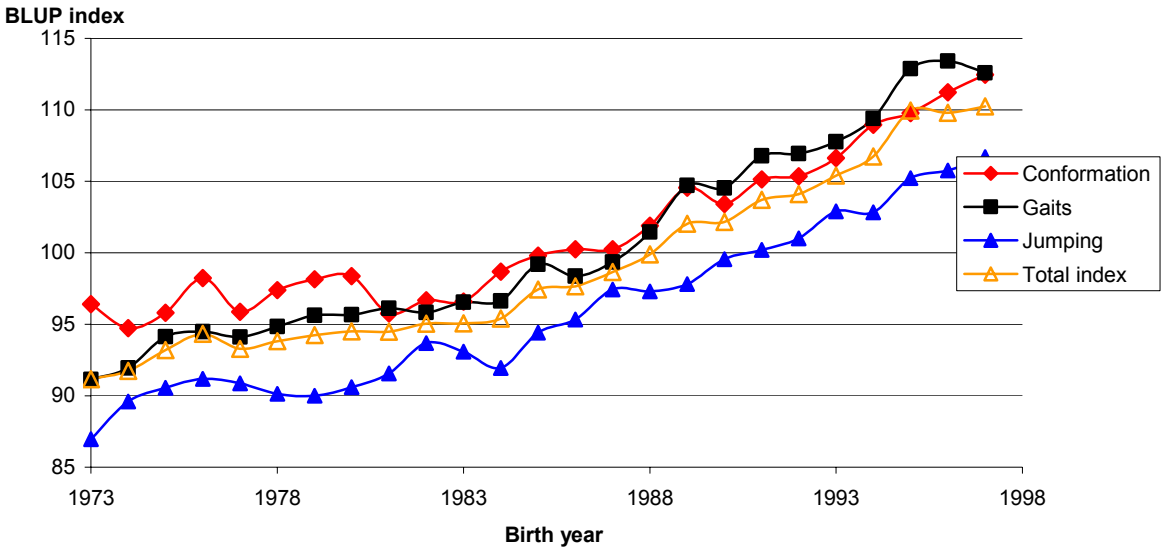


Figure 2. Genetic progress in Swedish riding horses based on RHQT.

Conclusions

Young horse tests for both sexes are very valuable in sporthorse breeding in Sweden. Results from the early seventies make up a unique data base.

Moderate to high heritabilities and high genetic correlations with competition at mature age demonstrate that one-day field tests for young horses and short stallion performance test are efficient and can be used as indicator traits for competition.

The results from young horse tests have successfully been used for early genetic evaluation of both stallions and mares. The genetic progress has been substantial.

It is time to develop the BLUP index by including information from test for 3-year-olds and competition into an integrated index. This is important in order to both get as reliable proofs as possible and for the credibility of the indexes among breeders, trainers and riders

Increased information activities are needed to inform breeders to make full use of the new genetic tools available and being developed.

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