

The influence of foreign stallions on the Swedish Warmblood breed

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Abstract

The purpose of this study was to survey the use of foreign stallions in the Swedish Warmblood (SWB) breed and to investigate how these individuals have influenced the SWB population. Since the early 1980-ies the genetic progress has been 0.85 and 0.53 genetic SD for show jumping and dressage, respectively. An open studbook is practised and foreign stallions have been used over the years to improve different characters of the breed. Data consisted of 202,808 horses included in the SWB routine genetic evaluation for 2006. Studbook of origin was determined for stallions with at least 5 progeny tested in Sweden. Those 757 stallions had together 116,505 progeny registered in SWB. The proportion of progeny sired by foreign stallions born each year has increased since the early 1980-ies, amounting to about 80 % 2006. The most favourable studbooks of origin for show jumping were Selle Français, Holstein and KWPN. For dressage there were not as clear results as for show jumping, but stallions from Oldenburg have had a positive influence during the last 15 years. Inclusion of genetic groups into the national genetic evaluation did not seem to ameliorate the evaluation and is thus not recommended.

Introduction

As many other European sport horse breeds, the Swedish Warmblood breed traces back to versatile horses used in agriculture or in the cavalry. As the horses gradually became replaced by machines, sport became the new focus for horse breeders. Especially the horses of the cavalry were suitable for this purpose. It was formally decided in 1850 that the Swedish horse should be separated into two breeds, or types: the lighter type, used primarily for the cavalry, and the heavy type, used primarily for farm work. The Swedish Warmblood Association was founded 1928 and 1939 regional studbooks were merged into what today is the Studbook of the Swedish Warmblood horse. The breeding goal for the Swedish Warmblood horse is “to produce a noble, correct and durable riding horse which through its temperament, rideability, good movements and/or jumping ability is internationally competitive”.

Importation of foreign genetic material has always occurred and the studbook has never been closed. Foreign influence has increased quite steadily in modern times and today about 80% of the foals born are by foreign stallions (Figure 1), which were imported live into Sweden or serve by imported semen.

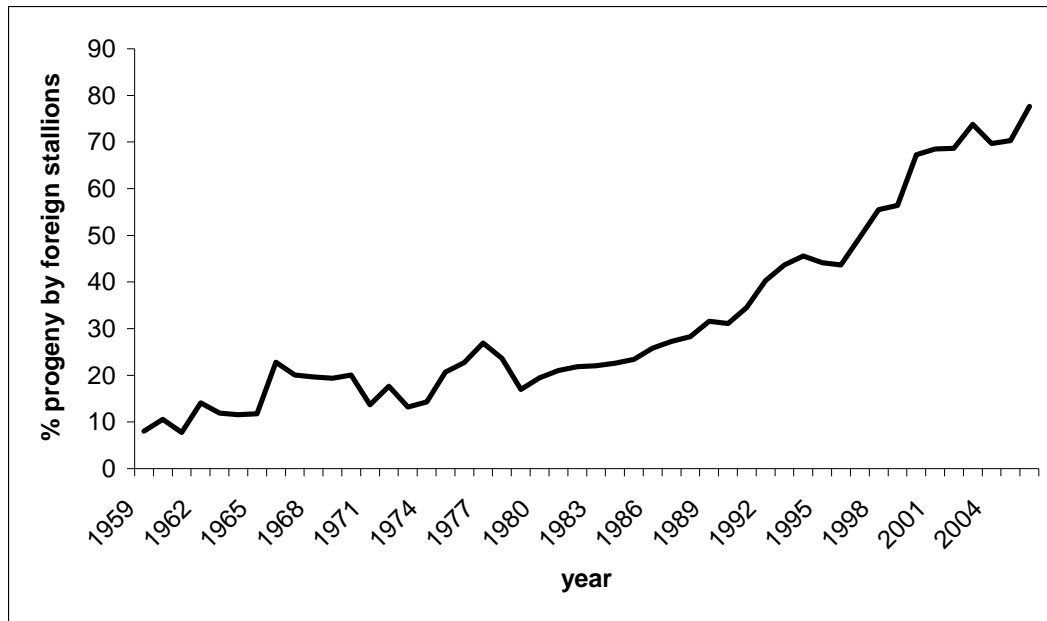


Figure 1. Percent progeny sired by foreign stallions per year

The national genetic evaluation of Swedish Warmblood horses includes results from performance tests of young horses as well as results from dressage and show jumping competitions. Consequently the EBVs for show jumping and dressage are integrated BVs estimated with a multitrait BLUP animal model, where the competition traits are representing the breeding goal. Since the early 1980-ies the genetic progress has been 0.85 and 0.53 genetic SD for show jumping and dressage, respectively (Figure 2).

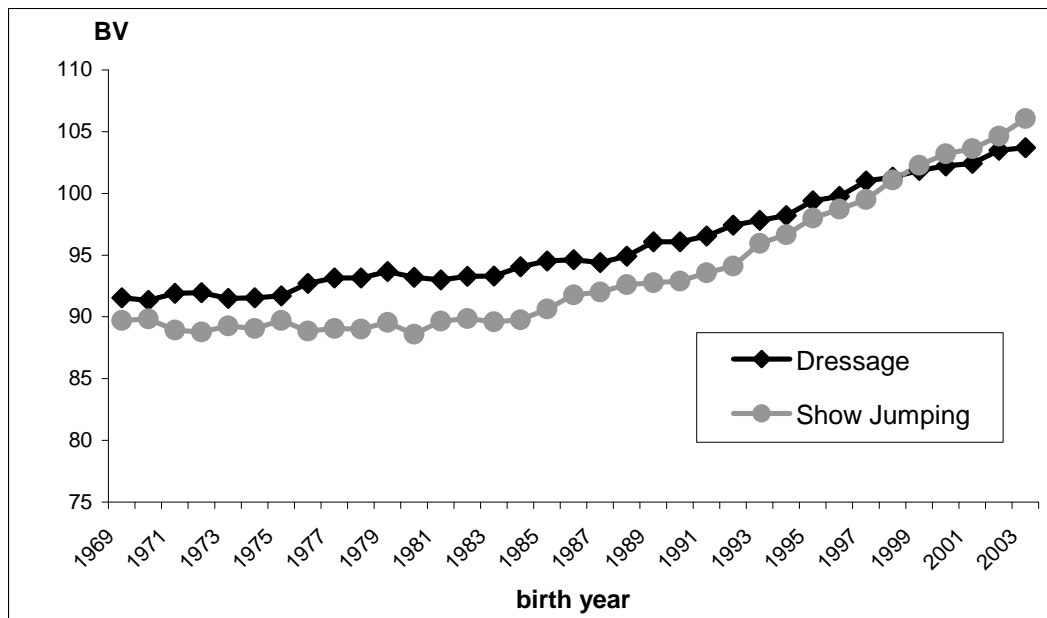


Figure 2. Average estimated breeding values per birth year for all horses registered by the Swedish Warmblood Association

To investigate the influence of foreign stallions on the Swedish Warmblood breed an analysis of variance of the impact of origin and time period on the nationally estimated breeding values (EBVs) for dressage and show jumping was performed. Furthermore, the impact of including genetic groups, based on origin and birth year, in the genetic evaluation was evaluated.

Materials and methods

Analysis of variance

An analysis of variance of the impact of origin and time period on the nationally estimated breeding values (EBVs) for dressage and show jumping was performed using proc GLM in SAS. The EBVs were taken from the Swedish routine national genetic evaluation (2006). Stallions with at least 5 tested progeny were selected for the analysis, altogether 757 stallions which together had 116,505 progeny registered by the Swedish Warmblood Association. Because the origin of horses is not registered in the database of the Swedish Warmblood Association, the origin of stallions was manually assigned. Origin was assigned as studbook or breed of first registration and time period was assigned as year of birth of first progeny in Sweden. Three time periods gave the most reasonable group size, with enough stallions per time period and origin; pre-1979, 1980-1989 and 1990-2003. These time periods were motivated by a) that Stud book registration of all Swedish warmbloods became compulsory 1980 and b) that the utilization of foreign stallions began to increase markedly around 1990 (Figure 1) and have continued to increase ever since. Some studbooks/breeds were represented by too few stallions to form a group of their own, especially after the partition of the data into time periods. Thus, they were merged into larger groups (Table 1).

Table 1. Grouping based on the origin of stallion and year of birth of first progeny in Sweden

Origin of stallion*	Number of stallions in each time period		
	-1979	1980-1989	1990-2003
AATh	39	38	18
DWB	3	5	10
Han	14	26	32
Holst	11	20	50
KWPN	3	13	36
Old	0	4	16
SF	3	4	9
Trak	11	5	6
Others	3	6	8
S	188	93	83
Total	257	214	268

* **AATh** = Thoroughbreds, Arabs, Anglo Arabs and Shagya Arabs, **DWB** = Danish Warmblood, **Han** = Hannover Verband, **Holst** = Holsteiner Verband, **KWPN** = the Royal Warmblood Studbook of the Netherlands, **Old** = Oldenburger Verband, **Others** = Belgian Warmbloods, one stallion from Great Britain, Irish Sport Horses and horses from the Westfalen studbook, **SF** = Selle Français (France), **Trak** = Trakehner (mainly German origin, but also Trakehners from Denmark and Poland), **SWB** = Swedish Warmblood

Thoroughbreds, Angloarabs, Arabs and Shagya Arabs were merged into the group “AATh”. This decision was based on the results of preliminary analysis of variances, where these origins had similar effects on the breeding values. Additionally the Arab breeds are closely related genealogically and not too distant from the Thoroughbreds. The stallions in the group “others” have nothing in common except being represented by very few stallions in our dataset.

Inclusion of genetic groups in the genetic evaluation

To evaluate the impact of genetic groups in the genetic evaluation of Swedish Warmblood horses we used a material including all horses with results in young horse tests, and/or competition (50 907 horses) plus their ancestors 6 generations back, altogether 95 385 horses.

Based on year of birth and origin, genetic groups were defined for horses with unknown parents in the pedigree. When the birth year of a parent was unknown, it was assigned as 6 years previous to the birth year of the oldest offspring. To determine the origin, we used the origin of the 757 stallions which had been assigned studbooks of origin for the analysis of variance. We then assigned origin backwards in the pedigrees. When origin of a parent was unknown, it was assigned the same origin as the progeny. Horses without an assigned origin after the described process were considered to be Swedish Warmblood horses. Origin of the phantom parents were then categorized into four groups for the analysis on show jumping and three for dressage. The categorization was based on the breeding goal of the stud books and on the results of the analysis of variance. In total 16 x 2 phantom parent groups were defined for show jumping and 12 x 2 for dressage (different groups for mares and stallions). The size of the foreign groups ranged from 40 to 318 horses for show jumping (520-10 602 for SWB) and between 145 and 554 for dressage (520-10 602 for SWB). Birth years of the phantom parents were categorized into four groups: pre-1950, 1951-1964, 1965-1983 and 1984-2003.

BLUP breeding values for dressage and show jumping, with and without genetic group effects in the model, were estimated with the DMU program. The following traits, normally included in the routine genetic evaluation, and the corresponding genetic parameters were used:

Show jumping

Score for jumping technique and ability recorded at performance test for 3-year-olds

Score for jumping technique and ability recorded at riding horse quality test (RHQT)

Show jumping competition result, lifetime

Dressage

Score for trot recorded at test for 3-year-olds

Score for “temperament gaits” (rideability) recorded at RHQT

Dressage competition result, lifetime

The RHQT, which is open for all 4 year old Swedish Warmbloods is also open for 5 year old Swedish Warmblood mares that have had foal as a 4 year old.

A trivariate animal model was used. Fixed effects included for the test for 3-year-olds were sex and year/place. For the RHQT the included fixed effects were sex, year/place and age and for competition sex and birth year. The EBVs were transformed to the publication scale of the routinely EBVs. That is with a mean of 100 and the genetic standard deviation set to 20. The reference population included all animals born 4 to 18 years before the year of estimation (i.e. 1988-2002) that had been tested in the test for 3-year-olds, in the RHQT or in competition. Finally, the correlations between BVs estimated with and without genetic groups were calculated for three different time periods corresponding to the three last birth year groups from the phantom parent grouping.

Results

Analysis of variance

The coefficient of determination for the model was high for show jumping (0.54), but considerably lower for dressage (0.26). Only statistically significant differences between foreign studbooks/breeds and SWB are accounted for in the following.

Show Jumping

The results for show jumping are displayed in fig. 3a. The most striking difference was that, compared to the Swedish born stallions, stallions originating from Holstein Verband, KWPN and Selle Français had significantly better BVs for show jumping in all three time periods even if the difference became smaller over time. Stallions from Hannover Verband and Danish Warmblood were better in the 2nd period and “others” were better in the earliest period. Finally, the “AATh” group and Trakehners were significantly worse in the last period.

Dressage

The results for dressage are displayed in fig. 3b. For dressage there were not as clear results as for show jumping. Compared to Swedish born stallions, stallions from Oldenburg Verband were better in the last period and stallions from Holstein Verband and KWPN were better in the first period. Stallions in the AATh group were worse than the Swedish born stallions in the last two time periods, the difference becoming larger over time and Selle Français stallions were worse in the last period.

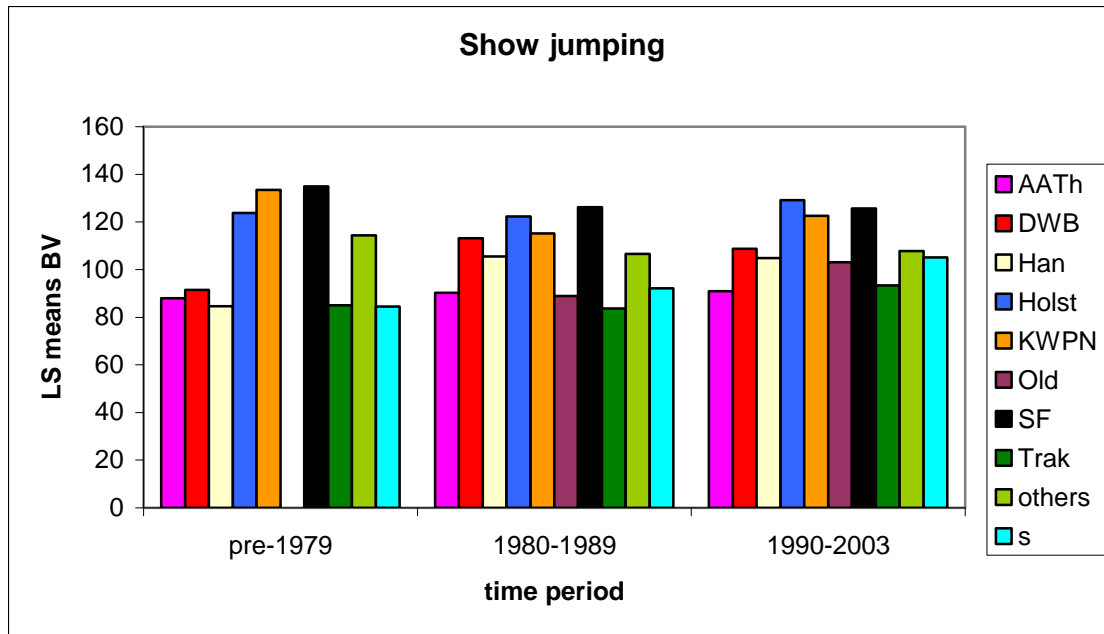


Figure 3a. LS means of show jumping breeding values for all time period - origin combinations

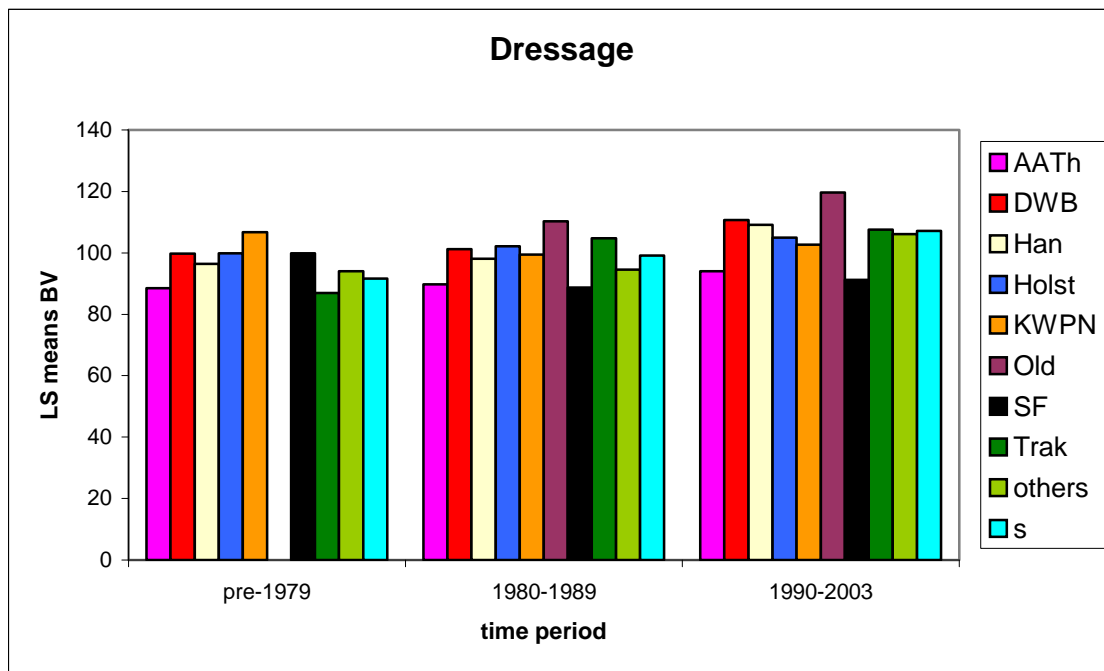


Figure 3b. LS means of dressage breeding values for all time period - origin combinations

Inclusion of genetic groups in the genetic evaluation

The solutions for the phantom parent groups fluctuated a lot over time and the SEs of the solutions were large.

We looked at the results for three, partly overlapping, groups of horses. They were: all horses, only horses with own observations and only stallions with at least 15 tested progeny, which corresponds to the stallions that get an officially published BV. For all groups, mean BV per year were lower when genetic groups were included in the analysis. There was also a tendency that the difference between BVs estimated with and without genetic groups became smaller over time. Regarding the stallions with at least 15 tested progeny, there were more fluctuations in BVs (because there were much fewer individuals) and the differences with and without genetics groups were smaller. In the latest years there was actually almost no difference.

Correlations

As seen in Table 2 the correlations between BVs estimated with and without genetic groups were high for stallions with the exception of the latest time period. Also for the horses with own observations the correlations were high for show jumping in some time periods, amounting to about 0.99. For the earliest born group of horses with own observations the correlations were rather low. This might be due to that the results of those horses include only competition results. As those have quite low h^2 for dressage, it affects the accuracy of the EBVs. This also means that they would be more prone to alter when the effect of genetic groups is added. Similarly, the correlation for the youngest group of stallions with at least 15 tested progeny is lower than for the other two age groups of stallions. Here, it might be due to the lower average number of tested progeny for this group of stallions, which also results in lower accuracy and hence more alterations of BVs.

Table 2. Correlations between BVs estimated with and without phantom groups for horses with own observations and stallions with at least 15 tested progeny in three different time periods, corresponding to the three last birth year groups from the phantom parent grouping

Group of horses	Birth year	No of horses	Correlation	
			Dressage	Show jumping
Horses with own obs	– 1964	770	0.81	0.96
Horses with own obs	1965 – 1983	17713	0.93	0.99
Horses with own obs	1984 – 2003	32424	0.96	0.99
Stallions with 15 tested prog	– 1964	25	1.00	1.00
Stallions with 15 tested prog	1965 – 1984	179	0.99	1.00
Stallions with 15 tested prog	1984 – 1998	129	0.94	0.96

Conclusions

Analysis of variance

Foreign populations have had a considerable impact on the show jumping performance of the Swedish warmblood breed in the past. As regards Holstein, SF and KWPN, they still have, although the differences are smaller today. Regarding dressage, it is difficult to say that any particular foreign population has had such a large impact on the performance as on the show jumping. Oldenburg stallions seem to be quite influential right now, but it has to be considered that a majority of the progeny of the stallions in this group are still quite young, so the EBVs rely mostly on young horse test results. Consequently, for dressage breeding it seems more important for the Swedish Warmblood Association and breeders to pinpoint good individuals among the foreign populations, than to rely on horses from a certain studbook.

Inclusion of genetic groups in the genetic evaluation

Regarding the inclusion of genetic group in the genetic evaluation of Swedish warmbloods, our preliminary recommendation is not to include genetic groups. At least not the groups used in this study, because the solutions for the genetic groups fluctuated a lot over time and the SEs of the solutions were very large. This could also indicate that our groups were not optimally composed. But, since the breeds constantly have been exchanging genetic material and since one individual can be registered in many studbooks, it is difficult to clearly assign a “breed” or studbook for each horse.

To conclude, genetic groups might have been useful in the genetic evaluations 30-50 years ago, but today, when the differences between Swedish born stallions and foreign ones seems to slowly level out, and correlations between EBVs for stallions with and without phantom parent groups are high, we do not believe it would add anything to the current routine genetic evaluation.

Acknowledgements

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