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Genetic parameters for growth traits of Holstein warmblood foals

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Abstract

Longitudinal records of four growth traits (bodyweight, wither height, foreleg length and cannon bone length) were taken for 291 breeding warmblood weanling colts between October 2004 and May 2005. For the genetic analysis average daily gain, respectively average monthly growth rates for the other selected traits were calculated for each colt. Genetic parameters of all traits were estimated multivariate with an animal model that included the fixed effects breeding farm, season of birth (early/late) of the colts and the random additive genetic effect of the animal. The heritability estimates were 0.23, 0.32, 0.05, and 0.22, respectively, for daily gain, monthly growth of wither, monthly growth of foreleg length and monthly growth of cannon bone length. High genetic correlations were estimated between monthly growth of foreleg and monthly growth of cannon bone (r_g = 0.91), respectively monthly growth of wither (r_g = 0.86). Medium correlations were found between monthly growth of wither and monthly growth of cannon bone (r_g = 0.57), accordingly for daily gain (r_g = 0.52). Negative or no genetic correlation was estimated between DG and MGCL (r_g = -0.41), respectively for MGFL (r_g = 0.01).

Introduction

Genetic traits of growth and weight are of interest for breeders to enable them to draw conclusions about achieving optimal development of foals and consequently, fit horses with high performance. Genetic parameters for weight and wither height have been analyzed during investigations of thoroughbred horses (Hintz *et al.*, 1978). In warmblood horses there are heritability estimates available for wither height (Von Butler and Krollikowsky, 1986; Stock, 2004). In contrast hardly anything is known about the genetic background of growth and weight rates in growing warmblood horses.

The aim of the study was to estimate variance components for growth traits in breeding foals of the Holstein warmblood.

Materials and Methods

Information. Data of 291 warmblood weanling colts (Holsteiner), sired by 78 different stallions, were collected by one person from October 2004 until May 2005. On 20 horse breeding farms in Schleswig-Holstein (northern part of Germany) body measurements of weight and growth were taken every six weeks, up to a maximum of five times during this period, resulting in a total of 1200 records. The following traits were measured: bodyweight (by a transportable balance), height at wither (by stick-measure), length of foreleg and length of cannon bone (by tape-measure).

For each colt from six to twelve months average daily gain and average monthly growth rate (of wither, foreleg length and cannon bone length) were calculated by subtracting the last from the first measurement and dividing this difference by the number of days between the two measurements. Preliminary analysis revealed that growth is on average approximately linear within this period (not shown).

Data collection of weight and growth was repeated in fall 2005 and will continue in February and May 2006. Table 1 shows the descriptive statistic for the resulting growth rates.

Table 1. M**ean, standard deviation (SD), minimum (Min.), maximum (Max.) of growth rates.**

Trait	Abbr.	N. of colts	Mean	SD	Min.	Max.
Daily gain (g)	DG	283	451.2	169.3	18.2	858.8
Monthly growth of withers (mm)	MGW	291	19.6	6.3	0.0	43.8
Monthly growth of foreleg length (mm)	MGFL	271	9.7	4.8	1.1	26.6
Monthly growth of cannon bone length (mm)	MGCL	284	2.7	2.1	0.0	10.7

Statistical Analyses. Calculation of significance of fixed effects on the respective traits was performed using the SAS procedure Mixed (SAS Institute Inc., 2000). The underlying model included the fixed effects breeding farm and season of birth of the colts (season 1: born before first of May 2004, season 2: born after first of May) and the random effect sire of foal. The effect breeding farm had a significant highly influence on all traits. The season of birth significantly affected the trait monthly growth of wither. Therefore, the younger colts, born in the second season, tend to have a higher daily gain and a higher growth of wither, respectively a higher growth of cannon bone length than the earlier born colts.

Variance components for the four growth rate traits were estimated multivariate with an animal model using REML in the VCE 4 package (Neumaier and Groeneveld, 1998). The model for the variance component estimation included the fixed effects breeding farm, season of birth of the colts and the random additive genetic effect of the animal. The pedigree data included four generations, in total 2096 animals.

Results and Discussion

Table 2 shows the results of heritability and genetic correlation for the traits of weight and growth rates from Holstein warmblood colts.

Table 2. Estimates of heritabilities (on the diagonal) and genetic correlations (above the diagonal) with their standard errors for the growth rates

Trait	DG*	MGW*	MGFL*	MGCL*
DG	**0.23±0.07**	0.52±0.10	0.01±0.39	- 0.41±0.13
MGW		**0.32±0.08**	0.86±0.24	0.57±0.17
MGFL			**0.05±0.03**	0.91±0.18
MGCL				**0.22±0.08**

* for abbreviations see Table 1.

In the existing literature only heritabilities for weight and wither height are given (Hintz *et al*., 1978 ; von Butler and Krollikowsky, 1986 ; Saastamoinen, 1990), and these could be difficult to correlate with rates of weight and growth in the present study. For this reason it might be seen critically to compare the results of this study with data from given literature.

Heritability estimated for monthly growth of wither was $h^2 = 0.32$ (Table 2), which tends to be similar to other studies with warmblooded horses with estimated heritabilities in the range of $h^2 = 0.21$-0.27 (von Butler and Krollikowsky, 1986; Stock, 2004).

The heritability of daily gain was estimated at $h^2 = 0.23$ (Table 2). Hintz *et al*. (1978) calculated heritabilities for the trait weight for thoroughbred foals in the ages ranging from six to twelve months in a large range from $h^2 = 0.13$-0.62, with higher values for older animals. Thus our result for heritability of daily gain concur with Hintz *et al*. (1978).

A very low heritability was estimated for the trait monthly growth of foreleg length with $h^2 = 0.05$ (Table 2). Causes for a reduced confidence in this result could be the influence of runout on hard paddocks or alternatively, the clipping of hooves shortly before time of measuring. Unfortunately no information for an appropriate modelling of both effects was available.

The heritability of monthly growth of cannon bone length was in accordance with the traits monthly growth of wither and daily gain with $h^2 = 0.22$ (Table 2).

Negative or almost no genetic correlation was found between the trait daily gain and monthly growth of cannon bone length, or respectively monthly growth of foreleg length. In contrast, very high genetic correlations were estimated between monthly growth of foreleg length and monthly growth of cannon bone length ($r_g = 0.91$, Table 2), and respectively, monthly growth of wither ($r_g = 0.86$, Table 2). This means foals with long forelegs will have long cannon bones and therefore will also tend to have a higher growth of wither height.

The moderate to high genetic correlation (r_g = 0.52, Table 2) between monthly growth of wither and daily gain provides an indication that foals, which have a regular through to moderately high daily gain will also grow faster in the wither height. Here the question is posed, to what extent is a high daily gain or a high monthly growth of wither desired. From an economic perspective of breeding and performance events in young horses, horses that mature early definitely have advantages. On the other hand, there have been various investigations which found a significant influence of growth rates of young horses on the disposition to develop orthopaedic diseases (Pagan and Jackson, 1996; van Weeren *et al*., 1999; Borchers, 2002).

5. Conclusion and Outlook

The heritability and genetic correlation estimates for daily gain, monthly growth of wither and monthly growth of cannon bone length indicate that breeding for a genetic change for the mentioned traits could be realized. This could be desired for example with regard to the approval of a stallion at the age of two and a half years. On the other hand there might be negative effects of fast growing on health traits such as orthopaedic diseases.

Therefore a number of colts were examined during the winter period 2004/05 to detect osteochondric lesions in the fetlock joint, the hock and the stifle-joint. These animals are currently undergoing radiographic examinations for a second time. It is planned to estimate correlations between the growth traits and the development of osteochondric lesions. With the knowledge of a possible genetic correlation between the intensity of growth and osteochondric lesions, a different breeding scheme can be set up that considers both simultaneously. However, further investigation is needed in regard to this complex.

References

Borchers, A. (2002) *PhD Thesis, Justus-Liebig-University*, Gießen.

Hintz, R. L., Hintz, H. F., and Van Vleck, L. D. (1978) *J. Anim. Sci*. **47**: 1243.

Neumaier, A. and Groeneveld, E. (1998) *Gen. Sel. Evol*. **30**: 3-26.

Pagan, J. D., and Jackson, S.G. (1996) *Pferdeheilkunde* **12**: 351-354.

Saastamoinen, M. (1990) *Acta agric. Scand*. **40**: 387-396.

Stock, K. F. (2004) *PhD Thesis*, *School of Veterinary Medicine*, Hannover.

Van Weeren, P. R.,Sloet van Oldruitenborgh-Ooste, M. M. and Barneveld, A. (1999*) Equine Vet. J. Suppl*. **31**: 26-30.

Von Butler, I. and Krollikowsky, I. (1986) *Züchtungskunde* **58**: 233-238.