Estimates of Breeding Values for Sires Based on Diagnoses Recorded at Hoof Trimming: Relationships with EBV for Conformation Traits

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Abstract

Heritabilities and genetic correlations for claw health parameters were estimated from data of around 16,000 cows with a total of around 50,000 observations, collected at time of trimming. The results show that substantial genetic variation within the range of a heritability of 5 to 33 % exists. This is also illustrated by substantial differences between sire families. Correlations with feet & leg conformation traits were mostly marginal and thus point to the need of recording the disorders directly when working on genetic improvement for the entire population.

Introduction

Claw disorders can be diagnosed at the time of hoof trimming (e.g. König *et al.,* 2005; van der Waaij *et al.,* 2005) and data stemming from a detailed collection of theses diagnoses can be subject to various kinds of analysis with respect to environmental and genetic factors. Previously, we have reported on aspects of the incidence of disorders, the effects of stage of lactation and parity, relationships with fertility and genetic influences (e.g. Pijl and Swalve, 2006). As in our previous studies, the data used for the present study originates solely from the collection of the last author while working as a professional hoof trimmer in around 100 herds located in North-Western and North-Eastern Germany. The data is recorded electronically on-farm using a PDA equipped with a custom-made computer program. The PDA connects to the home office computer which in turn is hooked up to the mainframe computer of the agricultural computing centre of Vereinigte Informationssysteme Tierhaltung (VIT, Verden). This set-up enables the pre-loading of all relevant individual cow data into the PDA. On-farm, individual diagnoses are added and farm parameters such as housing system are updated when necessary.

Aim of the present study is a genetic analysis comparing linear and threshold models when estimating variance components and breeding values. Furthermore, relationships between these breeding values and the official proofs for conformation are studied.

Material and Methods

The data included in this study covers about seven years of data collection in years 2000 to 2007 by the last author of this paper. The incidence rates for the eight most important disorders found are described in Table 1. The total number of observations was 49,875. Since the data originates from the routine work of a professional hoof trimmer, new clients are added as they newly enter the system and other clients may discontinue the service. Hence, not every cow can be followed throughout her life time. However, for most cows, repeated observations exist. Therefore, apart from the incidence rate of all observations, also incidence rates for cows which were trimmed by the last author for the first time (young cows, older cows for new clients) and for cows with a first trimming in 1st lactation are shown. The number of observations in the second column then also is equal to the number of individual cows. All cows were Holstein cows and the overwhelming majority was kept in loose housing with cubicle barns which differed only with respect to flooring and type of cubicle. The analysis presented here covers disorders and findings of the claws of the hind legs only. Disorders found at front legs are

recorded but were found to be too rare to warrant further analysis. It should be noted that the incidence rates shown in Table 1 include sub-clinical as well as clinical cases. We therefore stick to the term "disorders" rather than using "diseases". The eight most important disorders were subject to analysis. Disorders were coded either zero or one; i.e. the nature of the data was binary. For most of them, their definition should be quite clear. An exception may be "Rotation". We defined Rotation as a twisting and dislocation of the medial claw easily seen when the leg is lifted for trimming. This is not to be confused with the corkscrew condition. Under this definition, Rotation should be seen as an anatomical phenomenon rather than as a disease.

Table 1. Incidence rates in three subsets of the data.

	All Observations	All cows with a first examination done by R. Pijl	First trimming in 1st lactation
Name of disease	%	%	%
Laminitis	31.29	33.49	33.63
Dermatitis Digitalis	19.49	21.91	26.37
Dermatitis Interdigitalis	11.89	11.87	9.38
White line disease	13.78	14.38	13.85
Sole ulcer	6.63	5.50	4.73
Rotation	13.66	16.47	20.73
Interdigital growth (Tylom)	8.44	4.41	3.88
Thick hocks	3.26	2.97	3.02
No. of observations	49,875	16,681	10,444

For genetic analysis using ASREML2, (VSN, 2006) linear as well as threshold models were applied. For linear models, univariate as well as multivariate (8 traits) models were applied. Using a threshold model, it was not possible to run multivariate models. Under the threshold model, logit link functions as well as probit link functions were used. Both should lead to identical results for identical data. However, when using the probit link function, convergence problems were encountered arising from subcells of fixed effects that either contained only 0's or 1's. When applying the probit link function hence such cells were removed. This procedure may create some bias. When applying logit link functions, convergence problems were not encountered and thus no further editing took place.

As fixed effects, herd-visit-date along with days in milk and parity were fitted. The repeated nature of the records was accounted for by fitting a permanent environmental effect along with an additive genetic animal effect.

Results and discussion

Table 2 displays the estimates for heritabilities. As expected, the magnitude of the estimates differs most for disorders with low incidence rates. All estimates show that substantial genetic variation does indeed exist. This should warrant genetic selection in order to improve hoof health. Tylom (Interdigital growth) exhibits highest heritabilities. Among the more frequent disorders, laminitis shows heritabilities of between 0.14 and 0.20 depending on the definition as a linear or threshold trait. In relation to disease traits in general, heritabilities for laminitis are high and thus especially for this most frequent disease cow populations would benefit from the implementation of genetic improvement programs.

Genetic correlations among the eight disorders are displayed in Table 3. As it was not feasible to run a multivariate threshold analysis, the genetic correlations were

estimated with an eight-trait multivariate linear model (below diagonal) along with the respective heritabilities (on diagonal). Breeding values were estimated with a univariate threshold model applying the logit link function. Correlations among these breeding values for 120 bulls with ≥ 20 daughters were calculated and are shown for the sake of comparison above the diagonal. In general, very similar patterns of correlations are revealed under both approaches. Laminitis does show positive correlations with Dermatitis interdigitalis, White line disease and especially sole ulcer. As explained above, Rotation may not be viewed as a disease. As most correlations of Rotation with other disorders show a negative sign, Rotation may be looked at as an indicator of favourable claw health status. However, a preliminary analysis (data not shown) points to a non-linear effect of this disorder: Mild cases seem to be indicators of good resistance to other claw diseases while severe cases may result in early losses of animals.

Table 2. Estimates of heritabilities for claw disorders for four different methods and models.

	Linear model				Threshold model			
	Multivariate		Univariate		Logit link		Probit link	
	h^2	s.e.	h^2	s.e.	h^2	s.e.	h^2	s.e.
Laminitis	0.135	0.01	0.133	0.01	0.172	0.02	0.204	0.02
Dermatitis Digitalis	0.077	0.01	0.069	0.01	0.118	0.02	0.133	0.02
Dermatitis Interdigitalis	0.085	0.01	0.099	0.01	0.186	0.02	0.202	0.02
White Line Disease	0.050	0.01	0.047	0.01	0.099	0.02	0.102	0.02
Sole ulcer	0.065	0.01	0.064	0.01	0.184	0.03	0.171	0.02
Rotation	0.143	0.01	0.141	0.01	0.191	0.02	0.204	0.02
Tylom (Interdigital growth)	0.168	0.01	0.199	0.01	0.335	0.03	0.336	0.03
Thick hocks	0.075	0.01	0.058	0.01	0.173	0.04	0.149	0.03

Table 3. Estimates of heritabilities (in bold, on diagonal) and genetic correlations (below diagonal) under the multivariate linear model in comparison with correlations between EBV from univariate threshold models based on 120 sires with ≥ 20 daughters.

	LAM	DD	DID	WLD	SOL	ROT	TYL	HOC
Laminitis	**0.135**	0.12	0.31	0.15	0.49	-0.24	0.17	0.22
Dermatitis Digitalis	0.03	**0.077**	0.31	-0.05	0.18	-0.05	0.44	0.17
Dermatitis Interdigitalis	0.29	0.25	**0.085**	0.15	0.27	-0.09	0.29	0.02
White Line Disease	0.26	-0.05	0.17	**0.050**	-0.07	0.16	-0.11	0.05
Sole Ulcer	0.40	0.12	0.42	0.01	**0.065**	-0.23	0.22	0.17
Rotation	-0.12	0.09	-0.17	0.02	-0.11	**0.143**	-0.27	0.14
Tylom (Interdig. Growth)	0.15	0.25	0.49	-0.05	0.16	-0.22	**0.167**	-0.03
Thick Hocks	0.25	0.02	0.07	0.01	-0.02	-0.09	0.18	**0.075**

Again using the sample of 120 bulls with ≥ 20 daughters, correlations between the estimated breeding values for the susceptibility to the eight disorders with official proofs for feet & leg traits with the German system of linear scoring of conformation traits were estimated. Only very few correlations were significant. No significant correlations were found for foot angle. The correlation between rear-legs-side-view (RLSV) and Sole ulcer was r = .17 (more sickled, more susceptible). Hock quality was correlated with Rotation (r = .22; slim hocks, more rotation) and rear-legs-rear-view (RLRV) showed correlations of -.21 and -.29 with Laminitis and Sole ulcer, respectively (more parallel, less diseased).

The entire data set contained 214 A.I. sires with > 10 daughters. According to their breeding values, for each disorder the sires were assigned to a "resistance level". The top 54 bulls were assigned to "High", the bottom 54 bulls were assigned to "Low". Among the 214 sires, five sires-of-sons with more than 10

sons were identified. The distribution of their sons into the resistance levels is given in Table 4. The sires-of-sons A and B do not show any specific pattern except for the case that most of their sons seem to be resistant against Rotation. Sire D shows a very favourable distribution of his sons for Laminitis, Dermatitis digitalis, Dermatitis interdigitalis and Sole ulcer but not for White line disease. Sires C, D, and E exhibit a very unfavourable distribution for Rotation and it should be noted that C and D are sons of E. The results given in Table 4 thus reflect the heritabilities and correlations displayed in Tables 2 and 3.

Conclusions

Based on a substantial amount of data, the method of collecting observations on claw disorders/diseases at the time of hoof trimming can be regarded as being of great potential. Estimates of heritabilities reveal substantial genetic variation which could be exploited. Genetic correlations with conformation scores of feet & leg traits were marginal and thus indicate that conformation scores and genetic improvement of them will not have adverse effects on claw health but will also not be of great aid.

Table 4. Number of sons within quartiles of high / low EBV for the six most important claw disorders for five sires-of-sons (A to E; number of sons in total in parenthesis).

	Q	A (21)	B (12)	C (14)	D (13)	E (11)
LAM	High	7	1	4	10	1
	Low	3	4	2	-	3
DD	High	2	7	3	11	1
	Low	11	-	4	-	4
DID	High	5	2	5	9	1
	Low	4	3	1	-	4
WLD	High	9	1	3	-	2
	Low	2	1	2	7	3
SOL	High	4	-	2	12	5
	Low	5	9	1	-	2
ROT	High	9	6	-	-	-
	Low	-	1	7	6	10

Acknowledgements

The authors are indebted to the participating farms for the provision of the data and to VIT for supplying additional data.

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