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# Relationship between test day somatic cell score and conformation traits in Polish Holstein cattle

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## Introduction

Improvement of milk yield is the main goal of most dairy breeders, but it is well documented that single-trait selection for milk production leads to decreased disease resistance and reproduction efficiency (Dematawewa and Berger, 1998, Negussie et al., 2008). Mastitis is one of the most frequent and costly cow diseases, but in many countries, including Poland, the incidence of mastitis is not routinely recorded. The heritabilities of clinical mastitis reported in the literature are usually very low and vary from 0.02 (Negussie et al., 2008) to 0.05 (Lund et al., 1999). Therefore, correlated traits are used for indirect selection to improve mastitis resistance, chiefly somatic cell score (SCS - log-transformed somatic cell count) but also some conformation traits. The heritability of somatic cell score is also low, ranging from 0.06 (Dal Zotto et al., 2007) to 0.13 (De Haas et al., 2008). The magnitude of the correlated response in resistance to mastitis depends on the heritabilities and genetic correlations between the mastitis traits under selection. The genetic correlations between mastitis and SCS have usually ranged between 0.3 and 0.8, with the average correlation close to 0.7 (Rupp and Boichard, 1999, Negussie et al., 2008).

Some type traits are moderately heritable and at the same time show favorable genetic relations with mastitis and SCS (Dechow et al., 2003, Żarnecki et al., 2003, Haas et al., 2007). Genetic correlations between SCS and conformation have been investigated by several authors (Rogers et al., 1995, Rogers et al., 1998, Chrystal et al., 1999, Němcová et al., 2007). The highest correlations, as expected, were found between SCS and udder traits such as fore udder attachment, udder depth, teat length, teat placement, and dairy form. Boettcher et al. (1998) developed an udder health index which included SCS, 12 udder conformation traits and milking speed. Rogers (1993) analyzed the efficiency of selection indexes based on SCS, milk yield and several type traits, and found that udder depth, teat placement, foot angle had a substantial impact on reducing the undesirable response in mastitis.

The objective of this study was to estimate genetic relationships between daily SCS and conformation traits in the Polish Holstein-Friesian population.

## Material and Methods

Data consisted of 21,957 records with test day somatic cell counts (SCC) and 9 conformation traits of Polish Holstein-Friesian primiparous cows. The conformation traits included two descriptive traits: feet and legs and overall udder score, and seven linearly scored traits: rump angle and width, rear legs – side and rear view, foot angle, central ligament, and teat length. The closest test day SCC was matched to the date of type evaluation. SCC was log-transformed to somatic cell score (SCS).

The cows, daughters of 561 sires, calved at 18-48 months in 700 herds in 2006 and 2007. Restrictions of a minimum 10 cows per herd and sires with at least 20 daughters were imposed. The interval between date of test and date of type evaluation had to be less than 60 days.

Days in milk (15 to 180 days for type traits and 5 to 213 days for SCS) were divided into 11 stages for type traits and 9 stages for SCS. For conformation traits the stages were defined as 15-day intervals; for SCS the first 3 lactation stages were 10-day intervals and the next 6 stages as 30-day intervals. Two seasons of calving were created: April-September and October-March.

The Bayesian multi-trait method via Gibbs Sampling was applied for (co)variance component estimation for all 10 traits (Misztal, 1999). A linear model containing random additive genetic animal effect, fixed effects of herd-year-season-classifier (HYSC) and lactation stage, and fixed linear regression on age at calving was used for all type traits. Included in the analysis were 1,785 HYSC subclasses, 11 lactation stages and 52,005 animals. SCS was analyzed based on the linear model with the same effects as above except for fixed effect of HYSC, which was replaced by herd-year-season effect (HYS). There were 1,762 HYS and 9 lactation stages for SCS. The number of generated samples of (co)variance components was 100,000. The first 5,000 samples were discarded as the burn-in period.

## Results and Discussion

Descriptive characteristics of the data are shown in Table 1. The mean calving age of cows was 26 months. The SCS mean value of 3.51 was similar to the means reported for other populations. The means of descriptive traits were 79.15 for feet and legs and 78.01 for overall udder score, with a higher standard deviation for the latter. Average linear type scores were from 4.69 for rear legs – rear view and teat length to 5.51 for central ligament. For most linear type traits the standard deviations ranged from 1.03 to 1.49, except for rear legs – rear view, which had a standard deviation of 2.20.

Heritability of SCS (0.07) based on one test day was lower than most published estimates for SCS calculated for lactational SCS. Earlier estimates of $h^2$ for this trait in Polish HF population ranged between 0.08 and 0.22 (Ptak et al., 2007) and were similar to those estimated by Dal Zotto et al. (2007), Negussie et al. (2008), Liu et al. (2001) and Mrode and Swanson (2003). Some authors have reported higher than 0.07 heritabilities for SCS (de Roos et al., 2003, Jamrozik et al., 1998), but they used all test day SCS available during lactations and the RRM model.

The heritabilities of descriptive conformation traits were similar (0.13 for feet and legs, 0.12 for overall udder score). Among the linear type traits the least heritable were leg traits: foot angle (0.06), rear legs – rear view (0.08) and rear legs – side view (0.09). The highest heritabilities were obtained for teat length (0.33) and rump traits: rump angle (0.30) and rump width (0.29). The heritability of central ligament was 0.18. All estimates of heritabilities were low to moderate (0.06-0.33).

Phenotypic and genetic correlations are presented in Table 2. The phenotypic correlations between SCS and conformation traits were lower than the genetic correlations and often close to zero. The highest negative genetic correlations were between SCS and two descriptive conformation traits, i.e., feet and legs (-0.37) and overall udder score (-0.28), indicating that daughters of bulls with higher breeding value have lower SCS. Kadarmideen (2004) obtained much lower genetic correlations between SCS and the same descriptive type traits: -0.05 for feet and legs and -0.10 for overall udder score. The correlation between SCS and feet and legs obtained by Charfeddine et al. (1997) was small and in the opposite direction (0.11).

The genetic correlations between SCS and linearly scored type traits were lower than with the descriptive traits (Table 2). The negative correlations with central ligament (-0.18) and with foot angle (-0.13) were the highest among the linear traits. Teat length showed a negligible correlation with SCS (0.01), in contrast to the values published by Charfeddine et al. (1997) and DeGroot et al. (2002): 0.14 and -0.24, respectively. Rear legs - side view showed a relatively high positive correlation with SCS (0.24). Other linear leg and foot traits showed lower genetic correlations with SCS; the correlations with foot angle and rear legs - rear view were -0.13 and -0.10, respectively. The correlations between leg traits and SCS suggested that higher SCS is more likely in cows with sickled legs, toe-out legs and lower heels. Kadarmideen (2004) obtained a smaller and positive correlation between SCS and rear legs - side view (0.10), while DeGroot et al. (2002) and Charfeddine et al. (1997) obtained negative values for the same correlation: -0.61 and -0.15, respectively. DeGroot et al.'s (2002) genetic correlations for other leg traits were higher than our estimates, and negative: -0.48 for foot angle and -0.61 for rear legs - rear view.

SCS was positively correlated with both rump traits; the correlation with rump width (0.12) was higher than with rump angle (0.03). Rump traits were less correlated with SCS than leg traits. The positive correlation with rump width (0.12) indicates that narrow-rump cows have lower SCS. This estimate was lower than from DeGroot et al. (2002) but higher than from Mrode et al. (1998).

The heritabilities and genetic correlations with SCS suggest that both descriptive traits (feet and legs, overall udder score) may be useful for indirect selection for resistance to mastitis. Among the linear traits, central ligament and foot angle, with only slightly lower genetic correlations, might also be taken as traits indicating greater resistance to mastitis. These traits might also be considered for construction of a selection index aimed at reducing or at least stabilizing the frequency of mastitis.

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Table 1. Means and standard deviations (SD) of age at calving, SCS and type traits

| No. Trait*) | Mean | SD |
|---|---|---|
| 1. Age of calving | 26.27 | 3.17 |
| 2. SCS | 3.51 | 2.05 |
| 3. Feet and legs | 79.15 | 3.32 |
| 4. Overall udder score | 78.01 | 4.29 |
| 5. Rump angle | 5.27 | 1.11 |
| 6. Rump width | 5.46 | 1.19 |
| 7. Rear legs – side view | 5.36 | 1.03 |
| 8. Foot angle | 5.24 | 1.26 |
| 9. Rear legs – rear view | 4.69 | 2.20 |
| 10. Central ligament | 5.51 | 1.49 |
| 11. Teat length | 4.69 | 1.15 |

*) Description of type traits in Żarnecki et al. (2000)

Table 2. Heritabilities (on diagonal) and genetic (above diagonal) and phenotypic (below diagonal) correlations among somatic cell score (SCS) and conformation traits

| No. | Trait | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | SCS | **0.07** | -0.37 | -0.28 | 0.03 | 0.12 | 0.24 | -0.13 | -0.10 | -0.18 | 0.01 |
| 2. | Feet and legs | -0.03 | **0.13** | 0.67 | 0.09 | 0.24 | -0.61 | 0.64 | 0.57 | 0.38 | 0.04 |
| 3. | Overall udder score | -0.09 | 0.36 | **0.12** | -0.07 | 0.37 | -0.34 | 0.26 | 0.49 | 0.54 | -0.01 |
| 4. | Rump angle | 0.02 | -0.04 | -0.08 | **0.30** | 0.05 | -0.20 | 0.04 | 0.05 | -0.06 | 0.00 |
| 5. | Rump width | 0.00 | 0.13 | 0.07 | 0.07 | **0.29** | -0.08 | 0.32 | 0.26 | 0.19 | -0.04 |
| 6. | Rear legs – side view | 0.02 | -0.36 | -0.12 | -0.04 | -0.03 | **0.09** | -0.36 | -0.49 | -0.19 | -0.04 |
| 7. | Foot angle | 0.00 | 0.42 | 0.12 | -0.03 | 0.12 | -0.14 | **0.06** | 0.25 | 0.15 | -0.01 |
| 8. | Rear legs – rear view | 0.00 | 0.43 | 0.19 | -0.04 | 0.09 | -0.22 | 0.24 | **0.08** | 0.18 | 0.01 |
| 9. | Central ligament | -0.10 | 0.14 | 0.39 | -0.07 | 0.02 | -0.02 | 0.05 | 0.05 | **0.18** | 0.09 |
| 10. | Teat length | -0.03 | 0.05 | 0.06 | -0.02 | 0.03 | -0.03 | 0.04 | 0.03 | 0.05 | **0.33** |

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