



## Genetic parameters for foot and claw diseases/disorders in Holstein cows in the Czech Republic: A preliminary study

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In this study, we analyzed genetic parameter for foot and claw diseases/disorders from 29 377 lactations of 11 776 Holstein cows recorded on 7 farms in the Czech Republic from 2000 to 2016. Three groups of foot and claw diseases/disorders were defined: skin diseases (SD), including digital and interdigital dermatitis and interdigital phlegmon; disorders of the claw horn (CH) including ulcers, white line disease, horn fissures, and double sole; and overall claw disease (OCD) comprising all the recorded disorders.

There were 22 711 records of overall claw disease (OCD), with an average of 3 records per cow and 1.7 records per lactation; 10 196 records of INF, with an average of 2.1 records per cow and 1.4 records per lactation; and 8 489 records of CH, with an average of 1.56 records per cow and 1.56 records per lactation. A total of 61% of cows showed OCD at least once in their lifetime, and OCD was recorded in 43% of all observed lactations. For INF and CH, the respective values were 41.13% and 46.18% of cows and 24.40% and 18.51% of all observed lactations. For the purposes of analyses, foot and claw diseases/disorders were defined as 0/1 occurrence per lactation. For CM, traits were the number of CM cases per lactation (CMn) or defined as 0/1 occurrence per lactation (CM0/1). The longevity trait was defined as pseudo-survival rate (PSR) determined according to whether a cow was alive (1) or absent (0) from her herd on the test day within each lactation. Genetic parameters for analyzed traits were estimated using linear animal models that included the random additive genetic effect of animal (A) and the permanent environmental effect of cow (PE). Fixed effects for claw diseases and clinical mastitis were parity, farm, year and season of calving, and age at calving in classes. For longevity, a model with random regressions within both random effects was employed together with the combined fixed effects of herd, year, season, and parity. The foot and claw disease traits were mostly affected by the herd, the year of calving, age at calving, and parity. The estimated heritability for INF was 8.8%, whereas that for CH and OCD was 7.0% and 7.7%, respectively, and that for CM and longevity was 12.2% and 2.2%, respectively. Genetic correlations between foot and claw diseases/disorders and CM ranged from 3% to 12% according to trait. Permanent environmental correlations between foot and claw diseases/disorders and CM were negative, from -3% to -18%, as were genetic correlations between foot and claw diseases/disorders and longevity (from 0 to -1%). Permanent environmental correlations between foot and claw

### Summary

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diseases/disorders and longevity were also negative (from 0 to -1%) to approximately 400 days of life, followed by positive estimates (from 0 to 1.5%) particularly between INF and longevity, between 400 and 2000 days of life.

*Keywords: Holstein cattle, lactation incidence risk, genetic parameter, foot and claw diseases, longevity, mastitis.*

## Introduction

Claw and foot diseases/disorders are among the most important health traits in dairy cattle, with noticeable negative impacts on farm profitability and production efficiency, animal welfare, food safety, and food quality (Enting *et al.*, 1997, van der Waaij *et al.*, 2005, Egger-Danner *et al.*, 2013). Claw and foot diseases/disorders impair the milk production, reproduction, and longevity of cows. Reducing the incidence of these conditions can be achieved by improvement in management practices and possibly by genetic selection. Genetic selection depends on sufficient genetic variability that is manifested by a particular claw disease/disorder, as shown in many previous studies (e.g., Buch *et al.* 2011, Chapinal *et al.*, 2013, and Pérez-Cabal and Charfeddine, 2015).

The aim of our study was to estimate the genetic parameters for claw and foot diseases/disorders recorded in the Czech Republic and to analyze the genetic correlations between claw and foot diseases/disorders, clinical mastitis (CM), and longevity.

## Material and methods

Cases of foot and claw diseases/disorders from 29 377 lactations of 11 776 Holstein cows were recorded on 7 farms in the Czech Republic from 2000 to 2016, during both regular and emergency visits of trimmers. Three groups of foot and claw diseases were defined: skin diseases (SD), including digital and interdigital dermatitis and interdigital phlegmon; disorders of the claw horn (CH), including ulcers, white line disease, horn fissures, and double sole; and overall claw disease (OCD) comprising all the recorded diseases/disorders. For the purposes of analyses, foot and claw diseases/disorders were defined as 0/1 occurrence per lactation. For CM, traits were the number of CM cases per lactation (CMn) or defined as 0/1 occurrence per lactation (CM0/1). The longevity trait was defined as the pseudo-survival rate (PSR) that was determined according to whether a cow was alive (1) or absent (0) from her herd on the test day within each lactation (Sasaki *et al.*, 2015).

The following linear animal model was used to estimate genetic parameters for foot and claw disease/disorder traits and CM traits:

$$y_{ijklmno} = \text{parity}_i + \text{herd}_j + \text{year}_k + \text{season}_l + \text{age}_m + \text{pe}_n + a_o + e_{ijklmno}$$

where  $y_{ijklmno}$  is the analyzed trait: SD, CH, OCD, CMn, or CM0/1;  $\text{parity}_i$  is the effect of parity class  $i$  (4 levels: first, second, third, and fourth and higher parity);  $\text{herd}_j$  is the effect of herd  $j$  (7 levels);  $\text{year}_k$  is the effect of calving year  $k$  (17 levels);  $\text{season}_l$  is the effect of calving season (4 levels: January–March, April–June, July–September, and October–December);  $\text{age}_m$  is the effect of age at calving (13 levels);  $\text{pe}_n$  is the *random* permanent environmental effect on cow traits across  $n$  parity;  $a_o$  is the *random* additive genetic effect of cow  $o$ ; and  $e_{ijklmno}$  is the *random* residual effect.

The following random regression linear animal model was used to estimate genetic parameters for longevity:

$$y_{djkl} = \sum_{jtlq} \text{HYSP}_{jtlq} \phi_q(d) + \sum_{ktq} a_{ktq} \phi_q(d) + \sum_{ktq} pe_{ktq} \phi_q(d) + e_{djkl}$$

where  $y_{djkl}$  is the observation of PRS of cow  $k$  exhibiting trait  $t$  at days in milk (DIM)  $d$ ;  $\text{HYSP}_{jtlq}$  is the  $q^{\text{th}}$  random regression coefficient of the herd-year-season-parity group  $j$  with trait  $t$  ( $q = 0-2$ ), (herd, 7 levels; year, 17 levels; season, 4 levels: January-March, April-June, July-September, and October-December; parity 6 levels: 1<sup>st</sup> to 6<sup>th</sup> and higher parity);  $a_{ktq}$  is the  $q^{\text{th}}$  additive genetic random regression coefficient of cow  $k$  exhibiting trait  $t$  ( $q = 0-2$ );  $pe_{ktq}$  is the  $q^{\text{th}}$  permanent environmental random regression coefficient of cow  $k$  with trait  $t$  ( $q = 0-2$ );  $e_{djkl}$  is the residual random effect for each observation; and  $\phi_q(d)$  is the  $q^{\text{th}}$  Legendre polynomial at DIM  $d$ .

The pedigree file contained 24 628 records. Data were analyzed using the DMU package (Madsen and Jensen, 2010) or VCE 6.0 program (Groeneveld *et al.*, 2008).

Genetic correlations between traits were estimated using bivariate models.

There were 22 711 records of OCD, with an average of 3 records per cow and 1.7 records per lactation; 10 196 records of INF, with an average of 2.1 records per cow and 1.4 records per lactation; and 8 489 records of CH, with an average of 1.56 records per cow and 1.56 records per lactation. A total of 61% of cows showed OCD at least once in their lifetime, and OCD was recorded in 43% of all observed lactations. For INF and CH, the respective values were 41.13% and 46.18% of cows and 24.40% and 18.51% of all observed lactations. Recent studies have reported foot and claw diseases/disorders in 40% to 70% of cows (Sogstad *et al.* 2005, Buch *et al.*, 2011; Chapinal *et al.*, 2013, van der Spek *et al.*, 2013). In Czech Holstein, the frequency of claw diseases often exceeds 50% (Krpálková *et al.*, 2016).

The foot and claw disease traits were mostly affected by the herd, year of calving, age of calving, and parity. Differences between herds or years can be explained by differences in management. Krpálková *et al.* (2016) pointed out that better care and management combined with more inspection of legs leads to a higher recording of diseases. Furthermore, the frequency of recorded OCD has increased over the years because of a growing emphasis on claw health. The frequency of OCD increased with parity, with a higher incidence of disease being recorded at the beginning and end lactation and during the dry period. Older calving cows showed a higher frequency of OCD than the younger cows.

The estimated heritability of INF was 8.8%, whereas that for CH and OCD was 7.0% and 7.7%, respectively, and that for CM and longevity was 12.2% and 2.2%, respectively. These estimates are in line with those reported in the literature, which range from 1% to 17% (van der Waaij *et al.*, 2005, Buch *et al.*, 2011, Chapinal *et al.*, 2013, Pérez-Cabal and Charfeddine 2015). Genetic correlations between foot and claw diseases/disorders and CM ranged from 3% to 12% according to trait. Buch *et al.* (2011) reported 0% genetic correlation between CM and dermatitis and 32% genetic correlation between CM and sole ulcer. These values are in agreement with the results of the present study because our estimates of the genetic correlation between CM traits and claw disease traits were higher for disorders of the claw horn (CH), which includes ulcers, than for skin diseases (SD), which includes dermatitis (7% CH × CM0/1; 12% CH × CMn vs. 3% INF × CM0/1; 6% INF × CMn). Permanent environmental correlations between foot and claw diseases/disorders and clinical mastitis were negative from -3% to -18%. Genetic correlations between foot and claw

## Results and discussion

diseases/disorders and longevity were negative to -1%. Permanent environmental correlations between foot and claw diseases/disorders and longevity were negative (0% to -1%) to approximately 400 days of life, followed thereafter by positive estimates (from 0% to 1.5%), particularly between INF and longevity. Estimates of both genetic and environmental correlations between longevity and foot and claw diseases/disorders were small and non-significant.

## Conclusions

There is evidence that susceptibility to foot and claw diseases/disorders is heritable, although our estimates of heritability would benefit from larger datasets. We identified a genetic relationship between foot and claw diseases/disorders and clinical mastitis; however, the genetic correlations between these traits and longevity were very low and non-significant. This study represents the first step in developing a national genetic evaluation of foot and claw diseases/disorders in dairy cattle.

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