

## Analysis of foot and claw diseases/disorders in Czech Holstein cows

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Foot and claw diseases/disorders from 24 545 lactations of 10 340 Holstein cows were recorded on 7 farms in the Czech Republic from 1999 to 2018. Three groups of foot and claw 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 as well as overall claw disease (OCD) comprising all the recorded disorders. Between 1<sup>st</sup> and 305<sup>th</sup> days of lactation OCD was recorded in 52.56% of all observed lactations. For SD and CH, the respective values were 28.61% and 27.15%. For the purposes of analyses, foot and claw disorders were defined as 0/1 occurrence per lactation. Genetic parameters for analyzed traits were estimated using linear animal models which included the random additive genetic effect of animal (A) and the permanent environmental effect of cow (PE). Fixed effects for claw diseases were parity, farm, year and season of calving, and age at calving in classes. The estimated heritability for OCD was 13.84%, whereas that for CH 12.64% and for SD was 9.83%, for ulcers (U) 8.73% and for dermatitis digitalis and interdigitalis (DD) was 9.97%, respectively. Genetic correlation between SD and CH was 17.66%, while between SD and DD 98.4% and between CH and U 92.62%. The work was supported by the project QJ1510144 and the institutional support MZE-RO0718 of the Ministry of Agriculture of the Czech Republic.

**Keywords:** cattle, foot and claw disorders, genetic parameters, health traits, udder

### 1 Introduction

Claw and foot diseases/disorders are among the most important health traits in dairy cattle with noticeable negative impact on farm profitability and production efficiency, animal welfare, food safety and quality (van der Waaij et al., 2005, Egger-Danner et al., 2013). Claw and foot diseases/disorders cause impairing the milk production, reproduction and longevity of cow. Decreasing of the incidence of them can be achieved by improvement in management practices and possibly by genetic selection. Genetic selection depends on sufficient genetic variability that is manifested by particular claw disease/disorder as was showed in many published scientific papers e.g. Buch et al. (2011), Chapinal et al., (2013) or Pérez-Cabal & Charfeddine (2015). The direct economic importance of claw diseases as breeding objectives were observed by authors Krupová et al. (2016).

The aim of our study was to analyze the frequencies of claw and foot diseases/ disorders recorded in the Czech Republic including estimation of genetic parameters for the analyzed traits.

### 2 Materials and methods

Foot and claw diseases/disorders were recorded on 7 farms in the Czech Republic from 1999 to 2018. Dataset included 24 545 lactations of 10 340 Holstein cows comprising 35 717 records of foot and claw disorders. 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. For analyses, two particular diseases: a digital and interdigital dermatitis (DD) and an ulcer (U) were used beside SD, CH and OCD. The occurrence of disorders was examined in three parts of lactation: 1<sup>st</sup> to 90<sup>th</sup> days of lactation, 1<sup>st</sup> to 305<sup>th</sup> days of lactation and 200<sup>th</sup> to 450<sup>th</sup> days of lactation. For the purposes of estimation of genetic parameters, foot and claw diseases/disorders were defined as 0/1 occurrence per lactation. The following linear animal model was used to estimate genetic parameters for foot and claw diseases/disorders traits and CM traits:

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

where:

- $y_{ijklmno}$  – the analysed trait: SD, CH, OCD, DD, U  
 $\text{parity}_i$  – the effect of parity class  $i$  (5 levels, first, second, third, fourth, five and higher parity)  
 $\text{herd}_j$  – the effect of herd  $j$  (7 levels)  
 $\text{year}_k$  – the effect of calving year  $k$  (20 levels)  
 $\text{season}_l$  – the effect of calving season (4 levels, January – March; April – June; July – September; October – December)  
 $\text{age}_m$  – the effect of age at calving (13 levels)  
 $pe_n$  – the random permanent environmental effect on cow traits across  $n$  parity  
 $a_o$  – the random additive genetic effect of cow  $o$   
 $e_{ijklmno}$  – the random residual effect

The pedigree file contained 26 356 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 by bivariate models.

### 3 Results and discussion

The occurrence of foot and claw disorders in parity differed according particular disorder. Infectious diseases as SD and DD were more frequent in the lower parities in comparison to claw horn disorders. There was lower incidence of DD in higher parities. Number of records for claw horn disorders increased with parity especially number of ulcers.

When the records according days in milk are considered the highest incidence was found closely after calving and also at the end of lactation. Later is probably connected with treatment of claws before dry period of cow.

Lactation incidence rate for OCD (see Table 1) was much higher than those of SD and CH (see Table 1). Cows suffered more than one disorder per lactation, SD and CH combined in the course of lactation. The lactation incidence rate for SD and DD was higher in the first three months of lactation in comparison with the end of lactation. For CH and U, the ratios were opposite.

The relationship between incidence of foot and claw disorders in particular part of lactation is shown in Table 2.

**Table 1** Lactation incidence rate (%)

Days in milk	SD	CH	OCD	U	DD
1 <sup>st</sup> to 90 <sup>th</sup>	15.89	12.65	28.28	7.22	12.65
1 <sup>st</sup> to 305 <sup>th</sup>	28.61	27.15	52.56	18.33	24.46
200 <sup>th</sup> to 450 <sup>th</sup>	11.67	14.92	27.37	10.14	10.69

SD – skin disease, CH – disorders of the claw horn, OCD – overall claw disease, U – ulcers, DD – digital and interdigital dermatitis

**Table 2** Pearson's phenotypic correlations between parts of lactation (%)

Trait	1 <sup>st</sup> to 90 <sup>th</sup> × 200 <sup>th</sup> to 450 <sup>th</sup>	1 <sup>st</sup> to 90 <sup>th</sup> × 1 <sup>st</sup> to 305 <sup>th</sup>	200 <sup>th</sup> to 450 <sup>th</sup> × 1 <sup>st</sup> to 305 <sup>th</sup>
Skin disease	6.72	68.67	38.47
Disorders of the claw horn	9.97	60.21	45.06
Overall claw disease	3.34	59.65	35.45
Ulcers	12.06	58.88	49.52
Digital – interdigital dermatitis	5.32	65.99	39.73

**Table 3** Variances and heritability of foot and claw disorder traits in 1<sup>st</sup> to 305<sup>th</sup> days in milk

Trait	Additive variance	Variance of permanent environment	Heritability
Skin disease	0.018	0.005	9.83%
Disorders of the claw horn	0.022	0.012	12.64%
Overall claw disease	0.030	0.006	13.84%
Ulcers	0.011	0.011	8.73%
Digital – interdigital dermatitis	0.015	0.006	8.97%

It emerged that there is only low relationship between the incidence in the first part of lactation and the incidence of claw disorders at the end of lactation. The relationship between other parts lactation is intermediate or strong.

The heritabilities of foot and claw disorders (Table 3) were between 8.73% U and 13.84% OCD. Additive variance was higher than variance of permanent environment for the all disorders except for U.

The SD and CH disorders showed low genetic correlations (see Table 4). The Permanent environmental correlations between SD and CH were lower then genetic one. Both estimated correlations between SD and DD or between CH and U strong.

**Table 4** Genetic and permanent environmental correlations between foot and claw disorders

Traits	Genetic	Permanent environmental
SD × CH	17.66	5.80
SD × DD	98.40	97.62
CH × U	92.62	91.47

SD – skin disease, CH – disorders of the claw horn, OCD – overall claw disease, U – ulcers, DD – digital and interdigital dermatitis

Compare to recent studies that have reported prevalence of 40% to 70% of cow with foot and claw disease/disorder (Sogstad et al. 2005, Buch et al., 2011; Chapinal et al., 2013, van der Spek et al. 2013) the incidence reported in presented study is on average. In preceding analysis, Krpálková et al. (2016) also found the frequency of claw diseases/disorders over 50%.

The foot and claw diseases traits increased with parity with higher incidence of disease at the beginning of lactation and at the end of the lactation and during the dry period. Krpálková et al. (2016) point out that better care and management combined with more controls of legs leads to higher recording of diseases.

The reported estimates of heritability 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 & Charfeddine 2015).

#### 4 Conclusions

There is evidence that susceptibility to presented foot and claw disease/disorders is heritable. Presented study is the first step on the way to the national genetic evaluation of the foot and claw diseases/disorders in dairy cattle.

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