



Models for genetic evaluations of claw health traits in Spanish dairy cattle

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ABSTRACT

Genetic parameters of 7 claw health traits from Spanish dairy cattle were estimated and the predictive ability of linear and ordinal threshold models were compared and assessed. This study included data on interdigital and digital dermatitis (DE), sole ulcer (SU), white line disease (WL), interdigital hyperplasia (IH), interdigital phlegmon (IP), and chronic laminitis (CL) collected between July 2012 and June 2013 from 834 dairy herds visited by 21 trained trimmers. An overall claw disorder (OCD) was also considered an indicator the absence or the presence of at least 1 of the 6 disorders. Claw health traits were scored as categorical traits with 3 degrees of severity (nonaffected, mild, and severe disorder). Genetic parameters were estimated by fitting both a standard linear model and an ordinal threshold animal model. Around 21% of cows had at least 1 claw disorder, and the most frequent disorders were SU, DE, WL, and CL. Heritabilities of claw disorders estimated with a linear model ranged from 0.01 (IP) to 0.05 (OCD), whereas estimates from the ordinal threshold models ranged from 0.06 to 0.39 (for IP and IH, respectively). Repeatabilities of claw health estimated with the linear model varied from 0.03 to 0.18 and estimates with the ordinal threshold model ranged from 0.33 to 0.69. The global trait OCD was correlated with all disorders, except for IH and IP when the linear model was fitted. Two different genetic backgrounds of claw disorders were found. Digital dermatitis showed positive correlations with IH and IP, whereas SU was positively correlated with WL and CL. The predictive ability of the models was assessed using mean squared error and Pearson correlation between the real observation and the corresponding prediction using cross-validation. Regardless of the claw health status, the linear model led to smaller mean squared error. However, differences in predictive ability were found when predicting nonaffected and affected animals. For

most traits, healthy cows were better predicted using the threshold model, whereas the linear model fitted affected cows better. Correlations between the observed data and corresponding predictions support those results ranging from 0.01 to 0.34. Claw health traits showed enough genetic variance to be included in the selection goal for Spanish Holsteins to select animals with less susceptibility to claw health problems, and we suggest the linear model for implementing genetic evaluations of claw health traits.

Key words: claw disorder, dairy cow, genetic parameter, linear and ordinal threshold model

INTRODUCTION

Functionality and health traits were the focus of breeding objectives in the last 3 decades, as described by Miglior et al. (2005). Besides fertility and udder health, locomotion problems are one of the main concerns for dairy farmers worldwide. Claw disorders affect animal welfare but also lead to economic losses due to negative consequences on milk production (Warnick et al., 2001) and fertility of lame cows (Buch et al., 2011). Claw health can be improved by herd management (Pérez-Cabal and Alenda, 2014; Pérez-Cabal and Charfeddine, 2014), but also through genetic selection (Chapinal et al., 2013; Häggman and Juga, 2013; van der Spek et al., 2013).

In Spain, one-third of cows have at least 1 claw disorder, and most of them become chronic over time (Charfeddine and Pérez-Cabal, 2014). Currently, improving claw health in Spanish dairy cattle is being addressed by selecting for feet and legs conformation traits, but, as van der Linde et al. (2010) pointed out, correlations between conformation traits and claw disorders can differ depending on the populations being studied and the conformation traits (Swalve et al., 2008; Chapinal et al., 2013; Häggman and Juga, 2013). Therefore, to include claw health traits in the national breeding goal, the Spanish Holstein Association (CONAFE) implemented a centralized electronic recording system for claw disorders in 2012 called I-SAP (Charfeddine and Pérez-Cabal, 2014). Spanish trimmers either work independently

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or as part of claw trimming companies and service cooperative workers. The Spanish Holstein Association signed an agreement with the most important company in this sector, Anka Hoof Care (Navarra, Spain), to develop a regular electronic recording system of claw health data. At the same time, CONAFE also signed an agreement with Seragro S.C.G. (A Coruña, Spain), an important cooperative service that also started with its own electronic recording system for claw health data in 2012. Information from both sources are preset to be compatible and all data are saved in the same database.

The 2 prerequisites for selection are that the genetic parameters of claw health traits must be known and genetic evaluations must be implemented. The genetic parameters of claw disorders in Holstein cows have already been estimated in some countries, for example by Gernand et al. (2013) in Germany, Häggman and Juga (2013) in Finland, and Stoop et al. (2010) in the Netherlands. Heritabilities have also been estimated in other dairy breeds, such as Norwegian Red (Ødegård et al., 2013) and Ayrshire (Häggman and Juga, 2012). In all cases, despite the low variance associated with these traits, claw health traits were shown to be heritable and can be used in a breeding program provided that a good amount and quality of data are available. Usually, claw data are recorded as binary or categorical traits and, in theory, threshold models are the most suitable to analyze these kind of response variables. However, there are as many authors who used a linear model (Onyiro et al., 2008; Buch et al., 2011; Chapinal et al., 2013) as authors who fitted a threshold model (Koenig et al., 2005; Ødegård et al., 2013; Schöpke et al., 2013). The linear models led to robust estimations despite the violation of assumption of normality when using a categorical response (van der Waaij et al., 2005; Swalve et al., 2008). However, to our knowledge, no literature has compared the goodness of fit of linear and threshold models using cross-validation. Therefore, the objectives of the present study were (1) to estimate genetic parameters of claw disorders in Spanish dairy cattle and (2) to compare the predictive ability of linear and ordinal threshold models using a cross-validation method.

MATERIALS AND METHODS

Data Collection

The Spanish Holstein Association provided each trimmer involved in I-SAP a personal tablet with an application called DATPAT for record keeping in farms. The trimmer connects with the database via the internet to download herd animal data and to send information back after each working day. Data recording relies on an easy procedure. For every visit, which can be either

scheduled as a maintenance visit or an emergency visit requested by the farmer, the trimmer downloads data from previous visits to the farm and scores disease traits for each cow as follows: 0 for an unaffected cow, 1 for a mild disorder, and 2 for a severe disorder for each claw. Both heifers and lactating cows were scored, although in the current study only data from lactating cows were used. Workshops were held periodically to unify criteria and to train claw trimmers and were open for new trimmers to promote the I-SAP recording system. Mean incidence rates, standard deviations, and graphs showing the evolution of trimmer data over time were discussed in a theoretical session. During a practical session on farms, claw trimmers discussed the recording of claw health data in a set of 15 to 20 cows used as an example. The 6 claw disorders recorded by the claw trimmers were defined as follows.

- **Dermatitis (DE):** Erosion of the bulb and infection of digital and interdigital skin is recorded as dermatitis in a single trait. Dermatitis is a highly contagious infectious disorder consisting of an ulceration of the skin along the coronary band or on the interdigital ridge of the claw.
- **Sole ulcer (SU):** An injury through the sole of the claw capsule often complicated by an infection of the corium, with granulation tissue, necrosis, purulent exudates, and separation of the sole horn.
- **White line disease (WL):** A fissure or a separation, which occurs on the side wall or sole of the claw, enabling foreign material to penetrate and infect the white line region. The corium is affected with a bleeding disorder and, eventually, with necrosis and granulation tissue. Secondary infections with abscess formation are a common sequel.
- **Interdigital hyperplasia (IH):** An excess epidermal and hypodermal tissue occupying part or all of the interdigital space that usually does not cause lameness unless it becomes extremely large.
- **Interdigital phlegmon (IP):** A subacute or acute necrotic infection that originates in the interdigital skin leading to cellulitis in the digital region. It presents as severe, acute, or subacute lameness, invariably affecting one limb, with the swelling of the distal soft tissues resulting in the splaying of the toes.
- **Chronic laminitis (CL):** Results from the acute or subacute laminitis and often appears a few months after the attack of laminitis. Chronic laminitis is a pathophysiologic disturbance in blood flow in the corium that leads to a breakdown of the dermal-epidermal junction of the claw. As a consequence, the dorsal wall of the claw can be recognized by a concave shape.

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