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Short communication: Association of foot and leg conformation and body weight with claw disorders in Spanish Holstein cows

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ABSTRACT

Data of first-lactation Holstein cows including claw disorders, foot and leg type traits, and structure and capacity type traits were used to study the phenotypic association of conformation and body weight with claw health status. The claw disorders studied were digital and interdigital dermatitis, sole ulcer, white line disease, and an overall claw disorder trait, indicating the presence of any of the 6 claw disorders recorded by the Spanish I-SAP program. Body weight was estimated indirectly with the Von Bertalanffy equation using live weight, which was also estimated from body depth, stature, and chest width. Cows with poor scores for foot and leg traits were more likely to have a claw disorder, with the exception of rear leg rear view and foot and leg composite that did not show any association with the studied disorders. The heavier the cow was, the higher was the probability of having sole ulcer, white line disease, or overall claw disorder trait, but digital and interdigital dermatitis, as an infectious disorder, did not show any association with body weight. Therefore, it is recommended that the preventive trimming routine be improved, which means checking each cow at least once per lactation and trimming if necessary, to achieve balanced weight-bearing for heavier cows and cows with poor feet and leg classification.
Key words: claw disorder, feet and legs, body weight, trigger factor

Short Communication

Lameness, as an abnormal gait, is one of the main causes of losses in dairy cattle in terms of animal well-being and economics of the herd (Enting et al., 1997; Huxley, 2013). Moreover, lameness is mainly due to claw disorders as a result of multifactorial reasons at both cow and herd level, such as the number of lactation or age of the cow, housing type, and herd management conditions (Cook and Nordlund, 2009; Pérez-Cabal and Alenda, 2014; Pérez-Cabal and Charfeddine, 2014). Most authors have reported the phenotypic association of claw health status with locomotion and body condition of the cow, using claw disorders as explanatory variables. For example, Gomez et al. (2015) reported that hoof conformation changed in heifers affected by digital dermatitis (increasing heel height and claw angles, as well as the interdigital cleft), which has been used as a predictor of claw health status before claw disorders become symptomatic. But few authors in their research dealt with claw disorders as a consequence of foot and leg conformation and animal BW. The aim of the present work was to study the conformation of feet and legs and BW as potential trigger factors for claw health of the Spanish dairy cattle.

The claw health information was obtained from the I-SAP program (Claw Health information; in Spanish: Información de Salud Podal), implemented by the Spanish Holstein Association (CONAFE) in Spain since 2012, which is still ongoing. The trimmers periodically visit farms with the objective of checking all the cows of a herd each year, but they also collect data during emergency visits; for more information see Pérez-Cabal and Charfeddine (2015). For this study, we considered the claw health data recorded between 2012 and 2014. Six claw disorders were recorded as categorical traits: 1 was absence of disorder, 2 was mild diagnosis, and 3 was severe diagnosis. However, only 3 disorders were considered in this study because of the low prevalence of the other disorders: interdigital and digital dermatitis (**DE**) with a prevalence of 8.58%, sole ulcer (**SU**) with a prevalence of 16.18%, and white line disease (**WL**) with a prevalence of 7.20%. We also studied another trait called overall claw disorder (**OCD**), which indicates the absence or the presence of at least one of the 6 claw disorders; that is, including interdigital hyperplasia, chronical laminitis defined as concave dorsal wall (Egger-Danner et al., 2015), and interdigital phlegmon, not analyzed individually in this study. The score for OCD was the highest of the disorders diagnosed for a cow per lactation. Claw disorders were studied as

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binary responses, such that mild and severe diagnoses were grouped in one class, and only the diagnoses of rear feet were considered.

The conformation traits were routinely recorded by professional classifiers from CONAFE. Six foot and leg traits were considered as explanatory variables for the study of the phenotypic association with claw disorders: foot and leg composite, foot angle, bone structure, rear leg set, rear leg rear view, and locomotion (WHFF, 2014). The classifiers give the locomotion score only if the cow is not diagnosed as a lame cow; otherwise, they wait until the next visit.

A data set with type information and claw disorders of 16,246 primiparous cows were used (15,287 for locomotion) for analysis type I (association between each type trait and claw health). The linear type traits were grouped into 3 categories, such that 1 to 3 were low scores, 4 to 6 were intermediate scores, and 7 to 9 were high scores. The foot and leg composite was grouped following the ICAR Recording Guidelines (2014) as follows: fair (less than 75 points), good (from 75 to 79 points), good plus (from 80 to 84 points), and very good (from 85 to 89 points).

Last, we performed what we called analysis type II, where the explanatory variable studied for the presence of claw disorders was BW. However, BW was not recorded on farms and BCS was not available so we had to estimate it by a 3-step process. First, we obtained a prediction equation of live weight from several conformation traits related to body size; second, we predicted the live weight of the cows with claw health information; and third, we estimated the BW of those cows using the predicted live weight in the Von Bertalanffy equation (Korver et al., 1985). In a previous publication, we estimated live weight using the linear trait size (e.g., Pérez-Cabal et al., 2006). However, since 2004, cow size has not been recorded and we had to use historic information of 139,966 Spanish Holstein cows that were classified from 1986 until 2004 to obtain a reliable prediction equation. We performed a regression analysis using PROC REG with the STEPWISE option (version 9.2, SAS Institute Inc., Cary, NC) such that traits with a 5% level of significance remained in the final model. The model that best predicted live weight ($R^2 = 0.79$) included stature, body depth, and chest width, as follows:

$$\begin{aligned}\text{LW} = {} & 404.93162 + 16.75626 \times \text{body depth} \\ & + 8.06828 \times \text{stature} + 8.90758 \times \text{chest width},\end{aligned}$$

where LW is live weight. From this equation we obtained the live weight of 26,685 cows (data set for analysis type II) in first lactation with claw health information and 305-d milk production of the lactation at trimming. The BW was estimated using the Von Bertalanffy equation (Korver et al., 1985) with the predicted live weight, the known age of type classification from the classification records, and the same ratio birth weight-BW and maturity rate used in Pérez-Cabal et al. (2006) for the Spanish Holstein population. For the present analyses, BW was grouped in 3 classes according to the 25th and 75th quantiles such that low weight ($\leq$691 kg), intermediate weight (from 691 to 761 kg), and high weight (>761 kg). The statistical summary of traits used in the study is shown in Table 1.

Table 1. Summary of prevalence of claw disorders for each analysis and descriptive statistics (mean and SD) of conformation traits and BW

Item	Prevalence in analysis with conformation	Prevalence in analysis with BW
Claw disorder[1]		
DE (%)	6.48	6.46
SU (%)	11.49	13.65
WL (%)	5.18	6.19
OCD (%)	24.90	27.95
Conformation traits and BW	Mean	SD
Feet and legs composite	77.77	3.60
Foot angle	5.33	1.41
Bone structure	5.61	1.40
Rear legs set	5.23	1.32
Rear leg rear view	4.98	1.44
Locomotion	4.52	1.18
BW (kg)	725.35	52.97

[1]DE = dermatitis; SU = sole ulcer; WL = white line disease; OCD = overall claw disorder.

The 2 types of association analyses between the explanatory variables and the response variables related to claw health (DE, SU, WL, and OCD) were carried out using a binary distribution and a probit link function using the PROC GLIMMIX (SAS Institute Inc., Cary, NC). Odds ratios (**OR**) were calculated showing the probability of DE, SU, WL, and OCD for different levels of foot and leg traits and BW with respect to a reference, which was the most desirable, that is the largest score for all of them, except for rear leg set, which is an intermediate optimum. Odds ratios were significant if the 95% confidence interval did not include 1. The linear model fitted to each of the claw disorder traits (**CD**) mentioned above was

$$CD_{ijkl} = \eta_{ijkl} + \varepsilon_{ijkl},$$

where η_{ijkl} was a linear predictor, and ε_{ijkl} was the random error term, such that $\boldsymbol{\varepsilon} \sim N\left(\mathbf{0}, \mathbf{I}\sigma^2_{\varepsilon}\right)$ was the joint Gaussian distribution of model residuals ($\boldsymbol{\varepsilon}$), where $\mathbf{I}$ is an identity matrix and σ^2_{ε} is the residual variance. The