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Genetic parameters for lameness and claw and leg diseases in dairy cows

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ABSTRACT

Lameness in dairy cows is a serious welfare and economic problem in dairy production. The majority of all lameness cases seem to stem from claw and leg diseases. Indirect selection on claw health potentially might be feasible with lameness as indicator trait. Therefore, the genetic parameters for the 2 traits were estimated by applying both linear and threshold models. In addition, the impact of environmental effects, parity, and stage of lactation was analyzed. In total, 8,299 locomotion scores (1–5) of 326 dairy cows and 708 claw and leg disease diagnoses or treatments of 335 dairy cows from the dairy research farm Karkendamm (Institute of Animal Breeding and Husbandry, Christian-Albrechts-University, Kiel, Germany) were analyzed. Lameness was defined by a locomotion score of $\geq$3. Days in milk were limited to the range of 10 to 350 d. To quantify the effect of the claw disease digital dermatitis, a second data set without this disease was built; 52.8 and 36.4% (without digital dermatitis) of the cows were treated at least once; 47.2% of the cows were clinically lame at least at one time. Genetic parameters were estimated bivariately using the average information restricted maximum likelihood procedure as implemented in the DMU software package. The heritability estimates derived from the threshold model were about twice as large as the values based on the linear model. For lameness, the threshold heritability increased from 0.15 to 0.22 and decreased for the diseases from 0.24 to 0.22 after exclusion of digital dermatitis. The genetic correlations were high and even increased from 0.60 to 0.72 after the exclusion of digital dermatitis, which suggests that lameness (locomotion score) seems to be a good indicator for claw and leg diseases. Digital dermatitis seems to affect the mobility of the dairy cow less strongly than other claw and leg diseases.

Key words: dairy cow, locomotion score, lameness, claw and leg diseases

INTRODUCTION

Lameness in dairy cows is one of the major animal welfare issues in dairy production. It is a painful condition and causes economic losses through decreased milk production, impaired reproductive performance, and involuntary culling (Kossaibati and Esslemont, 1997). In German herds, lameness (claw and leg lesions) is the third main reason for early culling after mastitis and infertility problems. Annual statistics published by the German Cattle Breeders Federation (Bonn, Germany) show that the percentage of cullings because of feet and leg disorders among all cullings increased from 4.40 (1980) to 10.40% (2009) in the last 30 yr (ADR, 1980–2009). The majority of all lameness cases seemed to be caused by claw and leg lesions; Murray et al. (1996) quantified this amount at about 90%.

Much of the variability in foot diseases is associated with environmental factors, such as management and housing. Nevertheless, a few studies have found a genetic effect on such a trait (Koenig et al., 2005; Swalve et al., 2008; van der Linde et al., 2010). Therefore, apart from improvement of the environmental effects, claw health may be improved through selection. Direct selection on claw diseases is difficult because detailed inspection of the claws can be expensive and time intensive. Successful indirect selection demands a high genetic correlation between the indicator trait and claw health and the trait has to be heritable. Such a trait could be lameness recorded as an indicator trait for claw diseases. Controlling and examination of lameness at a herd level is potentially possible with a well-established locomotion scoring system. Several approaches were developed in the last 23 yr (Manson and Leaver, 1989; Sprecher et al., 1997). Thus, this trait might be more easily and inexpensively assessed than specific claw lesions (Boettcher et al., 1998). A few studies have reported heritabilities for locomotion, which is being used as an additional conformation trait in the type classification of Holstein-Friesian heifers (van der Waaij et al., 2005; Laursen et al., 2009; van der Linde et al., 2010). In contrast to the genetic parameters for claw health and locomotion, the parameters for lameness have not been well investigated.

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Thus, the first objective of this study was to examine the impact of the environmental effects, such as parity or stage of lactation, on lameness and claw and leg diseases. Then, taking the relevant fixed effects into consideration, the genetic parameters were estimated by applying both linear and threshold models.

MATERIALS AND METHODS

Data

Locomotion scores were recorded between September 2010 and February 2012 on the dairy research farm Karkendamm of the Institute of Animal Breeding and Husbandry, Christian-Albrechts-University Kiel (Germany). According to the system of Sprecher et al. (1997), 326 lactating Holstein-Friesian cows (primiparous and multiparous) were examined weekly for lameness (locomotion score) by one classifier. This system emphasizes the leg placement and back posture of the dairy cows and is expressed by 5 possible scores (1 = normal gait, 2 = mildly lame, 3 = moderately lame, 4 = lame, and 5 = severely lame). Locomotion was scored while the cows were standing or walking on the concrete slatted passageways at the feeding bunk or between the cubicles on 1 of the 2 concrete slatted floor systems. Cows in straw and the selection yard were not assessed. Before the start of the study period, all animals were examined weekly for 2 mo to train the judge in the procedure of scoring locomotion. As the emphasis of this study was mainly on the investigation of lameness in dairy cows and due to the low number of the more extreme scores (scores 4 and 5), the locomotion scores were dichotomized, using 3 as the cut-off. As shown in Figure 1, in almost 16% of the locomotion scores (3 to 5) cows were classified as lame. For further analysis, clinically lame cows were coded as 1 (score $\geq$3). If the locomotion was normal (scores 1 and 2), the value was set to 0.

In the same observation period as scoring locomotion, all claw and leg diagnoses and treatments were recorded by a veterinarian or farm staff. On the research farm, the claws of the animals were trimmed routinely until 100 d postpartum and before the dry period by one claw trimmer (farm staff). In addition to this routine, cows recognized as lame by locomotion scoring or farm staff were examined. All in all, 8 different claw and leg disorders were diagnosed and treated (Table 1). The main claw disease was sole ulcer with a frequency of 24%, followed by digital dermatitis with a frequency of about 22%. The frequency of leg disease was small (slightly less than 7%). The number of claw and leg diseases decreased from 771 to 708 in the final data set due to the restriction of being within 10 and 350 DIM. For definition of the trait claw and leg diseases, each day with at least 1 treatment was coded as 1. Additionally, the following 8 DIM were also coded as 1. The 8-d period was chosen because claw and leg diseases seemed to affect the cows for at least 1 wk (Buttchereit et al., 2012). All other days were classified as healthy (coded as 0). Days in milk were limited to the range of 10 to 350 d because of the small number of cows in the first days postpartum and above 350 lactation days. To quantify the effect of the claw disease digital dermatitis, a second data set without this disease was built.

Table 1. Frequencies (%) of the recorded claw and leg diseases

Diagnosis	Absolute frequency	Relative frequency
Sole ulcer	183	24
Digital dermatitis	167	22
Interdigital hyperplasia	148	19
Interdigital necrobacillosis	127	17
White line disease	61	8
Leg lesions (e.g., hock swelling)	51	7
Double sole	27	4
Undefined injuries	7	1
Total	771	

Table 2 summarizes the number of affected cows and the number of days coded as 1 for claw and leg diseases and lameness (score $\geq$3). In total, 52.8 and 36.4% (without digital dermatitis) of the 335 examined cows were treated at least once because of one or more claw and leg diseases, and 47.2% of the 326 rated cows were clinically lame at least at one time in the observation period.

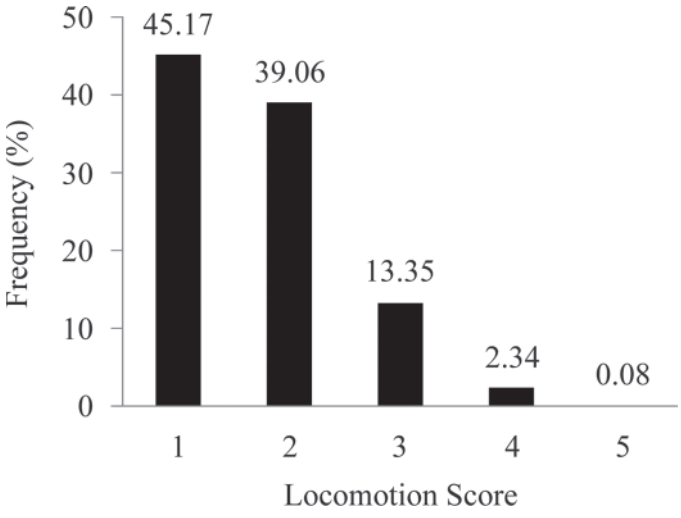

Figure 1. Frequencies of locomotion scores.