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Hygiene-related and feed-related hoof diseases show different patterns of genetic correlations to clinical mastitis and female fertility

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ABSTRACT

Hoof diseases are a problem in many dairy herds. To study one aspect of the problem, genetic correlations between 4 hoof diseases, protein yield, clinical mastitis, number of inseminations, and days from calving to first insemination were estimated in first-parity Swedish Red cows using trivariate linear animal models. Occurrence of dermatitis, heel horn erosion, sole hemorrhage, and sole ulcer were reported by hoof trimmers. The data set contained about 314,000 animals with records on at least one of the traits; among these, about 64,000 animals had records on hoof diseases. Heritabilities were low for all hoof diseases (0.03 to 0.05). The hoof diseases fell into 2 groups: (1) dermatitis and heel horn erosion (i.e., diseases related to hygiene) and (2) sole hemorrhage and sole ulcer (i.e., diseases related to feeding). The genetic correlations between traits within the 2 groups were high (0.87 and 0.73, respectively), whereas the genetic correlations between traits in different groups were low ($\leq$0.23). These results indicate that the 2 groups of hoof diseases are partly influenced by the same genes. All genetic correlations between hoof diseases and protein yield were low to moderate and unfavorable. Moderate and favorable genetic correlations were found between the feed-related hoof diseases and clinical mastitis (0.35 and 0.32), whereas the genetic correlations between the hygiene-related hoof diseases and clinical mastitis were low and not significantly different from zero. The genetic correlations between the hygiene-related hoof diseases and number of inseminations were low to moderate and favorable (0.32 and 0.22), and the genetic correlations between the feed-related hoof diseases and number of inseminations were low and not significantly different from zero. A moderate genetic correlation was found between sole ulcer and days from calving to first insemination (0.33), whereas the genetic correlations between days from calving to first insemination and sole hemorrhage and the hygiene-related hoof diseases were low and not significantly different from zero. In general, the 2 groups of hoof diseases showed different patterns of genetic correlations to the other functional traits, but both were unfavorably correlated to protein yield. A simulation study showed that inclusion of hoof diseases in the selection index will not only reduce the genetic decline in resistance to hoof diseases but also be favorable for other functional traits and improve overall genetic merit.

Key words: hoof disease, mastitis, female fertility, dairy cattle

INTRODUCTION

The incidence of hoof diseases is high in many dairy cattle populations. As an example, Sogstad et al. (2005) conducted a study of 2,665 cows that were trimmed by hoof trimmers who had been taught diagnosis and recording of hoof diseases. Their study showed that 41% of the cows housed in tie-stalls and 64% of the cows housed in freestalls had at least one disease in the hind hooves. Individual hoof diseases may be more difficult to record than lameness but it is a more precise measure of hoof health. Diseases in the hooves or the skin directly connected to the hooves may cause up to 90% of cases of lameness (Peterse, 1992; Webster, 1993). However, hoof diseases do not necessarily cause lameness. In the study by Sogstad et al. (2005) only 1 and 2% of the cows housed in tie-stalls and freestalls, respectively, were recorded as lame in the hind limbs. Other studies have also found few lame cows compared with the number of cows suffering from hoof diseases (e.g., Smits et al., 1992; Manske et al., 2002). Thus, direct measures of hoof diseases or a combination of direct measures of hoof diseases and lameness are preferred if data are available.

The total costs of a single case of lameness are considerably greater than the treatment costs alone because lameness may reduce milk yield (Warnick et al., 2001) and female fertility (Hernandez et al., 2001) and hasten culling (Booth et al., 2004). Kossaibati and Esslemont

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(1997) found, for instance, that the direct costs of lameness caused by a digital disease, an interdigital disease, and sole ulcer were £121, £76, and £152 per affected cow, respectively, including reduced milk yield, whereas the total costs were £240, £131, and £425 per affected cow under British conditions. The incidence can be reduced by improved management or by genetic selection. A crucial prerequisite for improving traits genetically is that they exhibit genetic variation. Previous studies have shown that this is the case for hoof diseases (e.g., Koenig et al., 2005; van der Waaij et al., 2005).

Both indirect selection based on correlated feet and leg conformation traits and direct selection based on veterinary treatments of feet and leg diseases are carried out today in the Nordic countries, but the genetic correlations between the 2 types of measures are not taken into account (NAV, 2010). The heritabilities of the feet and leg conformation traits are relatively high compared with those of the disease traits reported by veterinarians. However, the majority of the genetic correlations between hoof diseases and feet and leg conformation traits are low to moderate (van der Waaij et al., 2005; Uggla et al., 2008). It is, therefore, unlikely that selection on conformation traits has resulted in considerable improvements of hoof health. Manske et al. (2002) found in a Swedish study that 72% of the animals suffered from at least one hoof disease. In comparison, 2.1 cases of hoof diseases and 0.3 cases of laminitis were treated by veterinarians per 100 cows in the years 2002 to 2003 (C. Bergsten, Swedish University of Agricultural Sciences, Skara, Sweden, personal communication). The difference between the number of diseased animals and the number of treatments indicates that only the most severe cases are treated by veterinarians. As a consequence of the low frequencies, records on veterinary treatments of individual hoof diseases show lower heritabilities on the observed scale (e.g., Laursen et al., 2009). Hoof diseases are also treated by hoof trimmers and farmers but these treatments have not been recorded regularly in all Nordic countries. Information about hoof diseases have, however, been reported by Swedish hoof trimmers since 2003. This screening of the population gives a more realistic picture of the number of cases.

It is important to obtain knowledge about genetic correlations when aiming to implement new traits in the breeding goal. Dairy cows with high genetic merit for milk production are assumed to be more predisposed to diseases, because they allocate body reserves to milk production in early lactation. This is in agreement with the unfavorable genetic correlations that often exist between functional traits (e.g., udder health and female fertility traits) and milk production traits (for review, see Rauw et al., 1998). With regard to hoof diseases, Koenig et al. (2005) found unfavorable genetic correlations between hoof diseases and milk production in the range from 0.06 to 0.34. These results are consistent with the idea of an inexpedient allocation of resources to milk production traits at the expense of health and reproduction traits. The group of functional traits is more diverse than the group of milk production traits and therefore it may be difficult to predict the sign of the genetic correlations among functional traits. However, many studies have found favorable genetic correlations among functional traits (e.g., Kadarmideen et al., 2000). In line with these results, Koenig et al. (2005) found genetic correlations between hoof diseases and SCS in the range from 0.15 to 0.28. To the best of our knowledge, genetic correlations between hoof diseases and mastitis have never been estimated previously and genetic correlations between hoof diseases and female fertility have only been estimated in a single study (Onyiro et al., 2008). Besides their use in breeding programs, estimates of genetic correlations between hoof diseases and other traits of economic importance may lead to better understanding of the side effects of artificial selection; for example, whether the incidences of hoof diseases have changed because of artificial selection.

The objective of this study was to estimate genetic parameters for 4 hoof diseases and their genetic correlations to protein yield, 2 udder health traits, and 2 female fertility traits in Swedish Red (**SRB**) cows. A second objective was to quantify the effect of including hoof diseases in a selection index on the selection differential for the breeding goal traits.

MATERIALS AND METHODS

Data

Records on traits related to hoof health, milk production, udder health, and female fertility in first-parity SRB cows were extracted from the Swedish Cattle Database.

Hoof trimming records from January 2003 to March 2008 were included in the analyses. Records on dermatitis (digital or interdigital, **DE**), heel horn erosion (**HH**), sole hemorrhage (sole or white line hemorrhage, **SH**), and sole ulcer (ulceration of sole or white line area, **SU**) were reported by professional hoof trimmers. The diseases were assessed as no case, light case, or severe case. The recording scheme was established with focus on these traits because they are the most common hoof diseases in Sweden. The guidelines for the classification of the individual hoof diseases were developed by the Swedish Dairy Association, and all hoof trimmers who volunteered to report to the cen-