Investigation of claw health of dairy cows in Switzerland

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Abstract
Claw health of dairy cows was investigated in an observational study in different housing systems in Switzerland. Twenty-five professional hoof trimmers examined lameness (**LN**) and claw disorders on 4,621 cows in 290 farms within routine hoof trimming. 82 farms had tie-stall barns without exercise (**T1**) and 166 had tie-stall barns with exercise (**T2**), another 42 farms kept their animals in loose housing systems with exercise (**L2**). Observation period lasted from September 2001 until June 2002. Single claw disorders were joined together to four different diagnosis-complexes: Sole disorders (**SD**), white line disorders (**WD**), heel erosions (**HE**), and disorders of skin and interdigital space (**ID**). Environmental and management factors were documented in a questionnaire for analysing possible risk factors on claw health. Data from three breeding associations were available, including animal information and performance parameters. Prevalence was 15.7 % (SD), 13.6 % (HE), 10.0 % (LN), 6.1 % (WD), and 5.3 % (ID). LN and SD showed highest prevalence (13.2 %; 16.4 %) and highest odds ratio (OR = 1.89; 1.33) in T1. WD were more often detected in L2, accounting for 9.4 % (OR = 1.0). HE was identified most in T2 (17.1 %, OR = 4.72) and T1 (13.2 %, OR = 4.45). Disorders of skin and interdigital space were most frequently found in T2 (7.5 %, OR = 1.55).

Introduction
Claw disorders are a serious welfare problem in today's milk production. After infertility and mastitis, they are the third most common reason for involuntary culling (Enting et al., 1997). Claw disorders cause discomfort and pain in the cow and result in high economic losses. The aetiology of claw disorders is multifactorial (Greenough et al., 1997). Main influencing factors are breed and conformation of claw and horn (Alban, 1995), level of feeding and milk production (Green et al., 2002), age and lactation stage (Alban, 1995; Heuer et al., 1999), and housing and management, for example design of lying and walking area (Greenough et al., 1997; Vokey et al., 2001) and claw trimming strategy (Manson and Leaver, 1988b).
Since 1993, housing and management systems that are well adapted to the behavioural needs of farm animals have been financially supported in Switzerland (SR 910.12, 1998). In 2001, 61 % of all cows in Switzerland were kept in farms participating in the program RAUS, 17 % of the cows were housed in systems fulfilling BTS criteria (FOAG, 2002).
This study, based on the results of professional hoof trimming, was performed (1) to investigate animal prevalence of claw disorders in a large sample of Swiss dairy cattle

production, and (2) to identify the risk factors of these disorders, with special consideration of housing and management systems, typical for current dairy production in Switzerland.

Materials and Methods

The present study was a subproject from an integrated evaluation of selective animal friendly housing systems for dairy cows in Switzerland, by order of the Swiss Federal Veterinary Office. The Swiss Federal Research Station of Agricultural Economics and Engineering of Taenikon enlisted 25 professional hoof trimmers from the Swiss Claw Trimmers' Federation to record claw trimming results on 4,621 cows in 290 dairy farms. Observation period was from September 2001 to June 2002. Information on housing (barn type) and exercise (RAUS), design of resting area, use and quantity of litter, and claw trimming strategy of each farm was recorded in a questionnaire concerning environmental and management factors. Additionally, data of three breeding associations concerning animal information and performance parameters was recorded.

Table 1. Study design parameters within housing systems.

	Tie-stall barn without exercise (T1)	**Tie-stall barn with exercise (T2)**	**Loose housing with exercise (L2)**
No. of farms	82	166	42
No. of cows	1,109	2,514	998
Median herd size	15	15	25
range (cows)	4–39	3–70	9–75
Milk yield of previous lactation (kg)	mean 6,256 std 1,343	mean 6,461 std 1,538	mean 7,118 std 1,562

Diagnosis

The locomotion scoring of each cow was carried out by the hoof trimmer before restraining the animal in the trimming chute. The scale of lameness, described by Manson and Leaver (1988a) and modified by Lischer et al. (2000) ranged from 0 to 5 (0 = normal gait, 1 = splayfoot, 2 = uneven gait, 3 = mildly lame, possibly arched back, 4 = obviously lame, movement impaired, arched back, 5 = severely lame with difficulties to get up, extremely arched back).

During the procedure of claw trimming, front and hind hooves were examined for the presence of single claw disorders. Due to low prevalence, these were joined together to diagnosis-complexes, including sole disorders, white line disorders, heel erosion, and disorders of skin and interdigital space.

Statistical analysis

Data analysis was performed applying to the statistical package SAS (2002). Claw health was assessed in terms of the prevalence of lameness and diagnosis-complexes. Prevalence was defined as the proportion of animals with the outcome of a given disorder at claw trimming date. Claw disorder-complexes were analysed as binary distributed traits. Lameness was also transformed in a binary trait, dividing different levels of the lameness scoring in two classes. "Non-lame" animals (score = 0) were distinguished from "lame" animals (scores 1–5).

Associations between parameters to be considered as risk factors and the occurrence of a specific claw disorder were tested in two steps. First, an univariate χ^2-test was used to obtain an indication about the importance (level of significance, p) of the fixed effects for each diagnosis-complex. If p for a given factor was less than 0.25, a combined analysis was

performed, applying GLIMMIX, a SAS macro based on PROC MIXED. The macro uses iteratively reweighed likelihoods to fit a generalised linear mixed model. Odds ratios (OR) and 95% confidence intervals (CI) were calculated from the estimated parameters of the final model.

From all tested fixed effects, the following ones proved to be significant and were therefore included in the final model: housing system (tie-stall barn without exercise (T1), tie-stall barn with exercise (T2), loose housing with exercise (L2)), number of lactation (1, 2+3, >3) within milk yield class of previous lactation (heifer, <6000, 6000–7000, >7000 kg), lactation stage (0–100, 100–200, >200 days in milk), breed (Brown Swiss, Simmental, Holstein, others), and season of claw trimming (autumn: September–November, winter: December–February, spring: March–June).

For all traits a random farm effect (σ^2_{farm}) and a random effect of the claw trimmer ($\sigma^2_{claw\ trimmer}$) were inserted in the statistical model in order to account for effects such as farm management and claw trimming strategy within trimming person. A Likelihood-ratio test was performed to test the hypothesis $\sigma^2_{farm} = 0$ and $\sigma^2_{claw\ trimmer} = 0$ (Lindner and Berchtold, 1982).

Results

Cow Level Prevalence

The distribution of the cows by score of lameness was very uneven. 4,157 cows (90.0 %) did not show any indication of abnormal locomotion. Splayfoot was observed in 5.9 % (275 cows), uneven gait in 2.8 % (130 cows), mild lameness in 0.7 % (31 cows), obvious lameness in 0.5 % (23 cows), and severe lameness in 0.1 % (5 cows) of the animals.

In figure 1 prevalence of claw disorders within housing systems is presented. LN and SD were most frequently observed in cows housed in tie-stall barns without exercise (T1). WD were more often discovered in L2. Cows in both, T1 and T2, showed by far higher prevalence of HE in comparison with animals in L2. ID were observed about three times more frequent in T2 compared to T1 and L2.

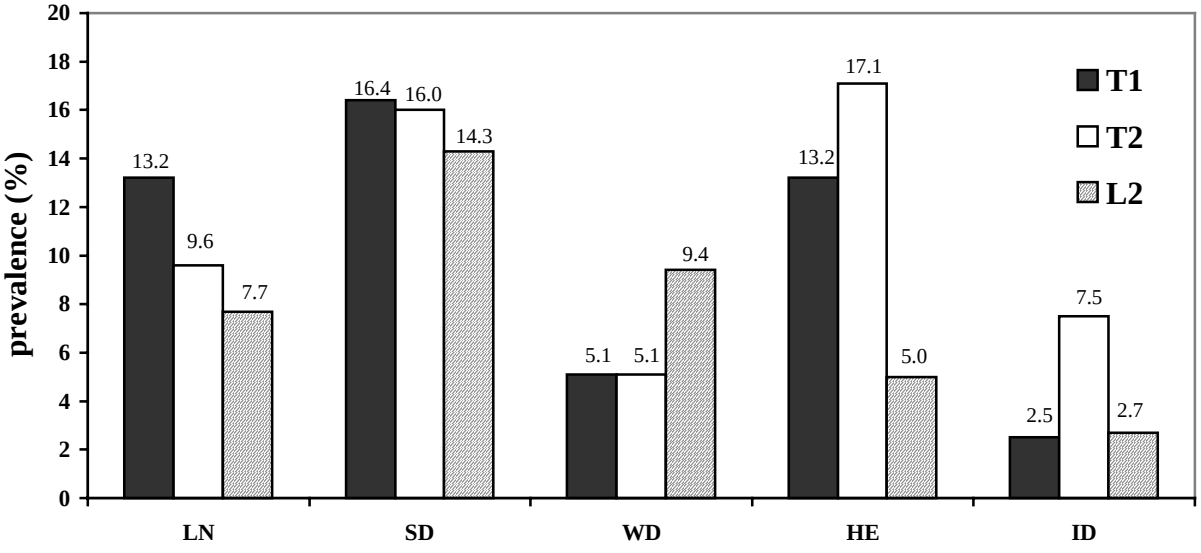

Figure 1. Distribution of animal prevalence of lameness (LN), sole disorders (SD), white line disorders (WD), heel erosion (HE), and interdigital disorders (ID) in Swiss dairy cows exposed to different housing systems (T1 = Tie-stall barn without exercise, T2 = Tie-stall barn with exercise, L2 = Loose housing with exercise) (n = 4,621).

Risk factors

Housing system ($p < 0.01$) had a significant effect on lameness, heel erosion, and interdigital disorders. Concerning lameness, cows in T1 had highest odds ratios (OR = 1.89). Cows housed in tie-stall barns, with or without regular outdoor exercise similarly, had a 4.5–4.7 times increased odds ratio for heel erosion compared to cows in loose housing systems. Disorders of skin and interdigital space were at the highest risk in T2 (OR = 1.55). The random effect of the herd and the random effect of the claw trimmer had significant effect ($p < 0.001$) on all observed traits. The herd effect accounted for 18 (SD) to 53 % (ID) on the total variance. The claw trimmer explained between 30 (SD) and 44 % (HE) of the total variance.

Discussion

Differences in the prevalence of lameness and claw disorders are caused by mainly two reasons. The first point is the difference between hoof trimmers in classifying lameness and disorders (Somers et al., 2003). According to Green (2003) the difficulty in defining lameness is the main indicator for explaining the high variability between the prevalence in the numerous cited papers. The high values for the variance component claw trimmer, ranging between 30 and 44 % on the total variance, support this assumption. The second reason is the exposure of animals to different levels of risk factors. This investigation pointed out a prevalence strongly varying between these levels. Enevoldsen et al. (1991) indicated that herd specific conditions were strongly associated with digital health.

In a recent investigation in Switzerland, Spycher et al. (2002) discussed the health and welfare of dairy cows in different housing programs. The results for lameness agreed mainly with the findings of this study. Lameness prevalence was lowest in BTS+RAUS with 10.1 %, slightly higher in RAUS (12.0 %), and highest in farms not participating in any program (16.2 %). In terms of risk of lameness, there was a marked advantage for loose housing systems and tie-stall barns with exercise compared to tie-stall barns without exercise. This fact might be explained by improved individual exercise in housing systems with pasture, which is in accordance with Gustafson (1993), who also observed less cases of lameness in tied animals when daily exercise was offered. In a study with only loose housing more lameness cases were identified when permanent access to an outdoor exercise yard was denied (Beaudeau et al., 2000). Kümper (2000) argued that in tie-stalls restricted movement and exceeding horn growth were the most severe problems. Kofler (2001) described the positive effect of exercise on claw health. Exercise stimulates blood flow in the claw and therefore, the transport of nutrients and oxygen in the horn-producing area is improved. But excessive movement on hard surfaces may contribute to sole contusions and lameness. Bergsten and Herlin (1996) found higher scores of haemorrhages of the white line in cubicle systems compared to tie-stall barns. These findings agreed with the results of the present study, demonstrated by a twice increased risk for white line disorders in loose housing systems. In this context, Blowey (1990) termed rough, uneven and pitted concrete floors and concretes made with a sharp aggregate as predisposing factors for white line infections and abscesses. Bergsten and Herlin (1996) stated that there was no uniform pattern between the two housing types in the prevalence of haemorrhages of the “sole zones”. This is also in agreement with our outcome, that there was no significant difference between both, tie-stall barns and cubicles, regarding sole disorders.

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