**Abstract**

**Background:** The main aim of the study was to assess the prevalence of claw and limb disorders in Norwegian beef-cow herds.

**Methods:** Twenty-six herds with ≥15 cow-years were selected by computerized systematic assignment from the three most beef cattle-dense regions of Norway. The study population consisted of 12 herds with 28 heifers and 334 cows. The animals were trimmed and examined once by claw trimmers during the late winter and spring of 2003. The seven claw trimmers had been taught diagnosing and recording of claw lesions. Environment, feeding and management routines, age and breed, culling and carcass characteristics were also recorded.

**Results:** Lameness was recorded in 1.1% of the animals, and only in hind claws. Pericarpal swellings were recorded in one animal and peritarsal lesions in none. In total, claw and limb disorders including lameness were recorded in 29.6% of the animals, 4.1% with front and 28.2% with hind limb disorders, respectively. Most lesions were mild. Laminitis-related claw lesions were recorded in 18.0% of the animals and infectious lesions in 16.6%. The average claw length was 84 mm in front claws and 89 mm in hind claw. Both laminitis-related and infectious claw lesions were more prevalent with increasing age. Carcasses from animals with claw and limb disorders were on average 34 kg heavier than carcasses from animals without such disorders (p = 0.02). Our results also indicate association between some management factors and claw lesions.

**Conclusion:** The study shows that the prevalence of lameness was low in 12 Norwegian beef-cow herds compared to beef-cattle herds in other countries and also that there were less claw and limb disorders in these herds compared to foreign dairy-cattle herds. The prevalence of lameness and white-line fissures was approximately the same as in Norwegian dairy herds whereas less dermatitis, heel-horn erosions, haemorrhages of the sole and the white line and sole ulcers were recorded.

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**Background**

Lameness is an important cause of reduced animal welfare and has been shown to cause substantial economical losses in dairy and beef-cattle herds [1,2]. Diseases of the feet account for ≥90% of all lameness cases in dairy cattle [3,4] and ≥70% in feedlots [5,6].
Claw disorders can be divided into three main categories according to their aetiology: infectious/partly infectious, metabolic/mechanical and traumatic [7]. Infectious and partly infectious claw lesions as dermatitis, heel-horn erosions and interdigital phlegmations are mainly influenced by the environment. Haemorrhages of the sole and the white line, sole ulcers and white-line fissures traditionally have been described as retrospective signs of subclinical laminitis, but lately by the term "claw-horn disruption" [8]. Important traumatic injuries are pedal bone fractures and traumas to the sole and interdigital space by foreign bodies. Laminitis (pododermatitis aseptic diffusa), laminitis-related lesions and injuries (bruises, lacerations and broken bones) are considered to be the most important non-infectious diseases in feedlot cattle [9]. To our knowledge, clinical prevalence of claw and limb disorders in beef-cow herds has not been reported before.

Environmental factors have huge influence on the incidence of claw lesions. Stanek et al. [10] found that the claw condition of fattening bulls was worse in a tie-stall system versus an outdoor untied paddock system, whereas Lawrence et al. [11] found that wet pen conditions increased both hoof growth and wear in Angus steers. Most studies have found that dairy cattle housed in free stalls have a higher claw lesion score than cattle in tie stalls [12-15]. The negative influence of confined dairy systems can be reduced by a well designed housing system [16].

In 2002 there were 48,497 beef cows in Norway versus 40,267 in 2000 [17]. The mean number of cow-years per herd was 15 and 14, respectively. Beef-cow production requires less labour, time and expenses compared to milk and meat production in dairy herds. Less meat from dairy herds and consumers demanding high quality steaks probably also results in further increase in beef-cow production in Norway. Herd sizes are expected to increase and more intensive production will probably predispose for more disease. In Norway, monitoring of health and disease is poorer in beef herds than in dairy herds. The recording system for production and diseases in beef-cow herds, the Norwegian Beef Cattle Herd Recording System (NBCHRS), which also includes claw and limb diseases, is established, but the health records are not complete.

The present study was part of a project on claw health of Norwegian cattle and the aim was to assess the prevalence of claw and limb disorders in Norwegian beef-cow herds. Some associations to breed, age, environment, management, reproduction and carcass characteristics are also assessed.

**Methods**

**Selection procedure**

We designed a cross-sectional study. Twenty-six herds registered in the NBCHRS and with ≥15 cow-years from the three most beef cattle-dense regions of Norway were sampled by computerized systematic assignment. Fifteen herds were excluded because of non-compliance in connection with the trimming and recording of claw lesions. Claw and limb disorders and claw length and shape in cows and heifers ≥ 18 months of age were recorded.

**Study population**

The final study population consisted of 12 herds: 6 in region I (Hedmark/Oppland), 3 in region II (Rogaland) and 3 in region III (Trøndelag). The total number of beef-cow herds with ≥ 15 cow-years within the three regions was 213, 71 and 169. Respectively 66, 14 and 45 of these herds were members of the NBCHRS. The total number of beef-cow herds with ≥ 15 cow-years in Norway was 1782 and 232 were members of the NBCHRS.

The mean number of cows and heifers in the study herds was 30 and the total number was 362; 28 heifers (more than 30 days from first calving) and 334 cows. Data from 337 of these animals were available from the NBCHRS. Housing, management, feeding and cow variables in each herd are in Table 1, 2 and 3.

The Hereford breed was present in 5 of the herds and Aberdeen Angus, Charolais, Limousine and Simmental in respectively 3, 6, 3 and 1 of the herds. In total 72 Herefords, 97 Charolais, 14 Aberdeen Angus, 20 Limousines, 15 Simmentals, 93 cross-breeds and 26 animals of unknown breed were included in the study. Animals with more than 75% of one breed were counted as pure-bred.

**Recording of data**

All seven professional claw trimmers attended two courses covering observation and recording of lameness, claw trimming procedures, diagnosis, recording and treatment of claw lesions. Individual training was given to each claw trimmer at the initiation of the practical work. For practical reasons two claw trimmers cooperated in some of the herds. All trimmers had previously participated in a study of claw health in dairy cattle [15].

The cows were trimmed and examined once during the period from the 15th of January 2003 to pasture season started. The last herd was visited on the 12th of June. Lameness was assessed when the animal was moved to the trimming chute as absent (no notation), moderate (1) or severe (2) (Table 3). Pericarpal and peritarsal swellings and wounds were recorded as absent (no notation), swelling (1), wound (2) or both swelling and wound (3). Claw
shapes were recorded as normal (no notation), asymmetric (1) or corkscrewed (2). Claw lesions were diagnosed on the basis of macroscopic examination before and after trimming to the correct claw shape. The trimming technique included levelling the two claws, aiming for symmetric bulbs. The axial and abaxial walls were both intended to be parts of the bearing surface and the two claws were trimmed flat and balanced with each other. The caudal 2/3 of the axial sole of both claws was dished out. Dermatitis, heel-horn erosions, haemorrhages of the white line and the sole, sole ulcers and white-line fissures were scored as absent (no notation), mild (1), moderate (2) or severe (3). Definitions in Table 4 are adapted from Bergsten [18]. We used only one variable for "dermatitis" because the occurrence of digital dermatitis is close to zero in Norway and we assumed that the recorded cases would be interdigital dermatitis. The presence of double sole, interdigital hyperplasia, horizontal and vertical fissures, interdigital phlegmon and papillomatous dermatitis was also recorded. The recording protocol did not differentiate between the inner and the outer claw because most lesions occur in the outer hind claw and the inner front claw [19,4]. The term “claw and limb disorders” includes lameness, pericarpal and peritarsal swellings or wounds and all claw lesions in this study, but not asymmetric or corkscrewed claws.

Identity, age, date for calving, breed and events as disease and carcass characteristics were extracted from the NBCHRS. When associations between age and claw lesions were assessed, the animals were separated in young (2–4 years), medium-aged (5–7 years) and old animals (8–10 years). Conformation class and fat cover class were defined according to the EUROP grading system as defined by the EU [20,21]. Data on housing system, environment, feeding and management were collected by visits and questionnaire survey by one animal husbandry adviser.

### Statistical analyses

The statistical analyses were performed in the SAS-PC System® Version 9.1 for Windows at cow and herd level. PROC UNIVARIATE, PROC MEANS and PROC FREQ were used for the descriptive analyses.

### Table 1: Housing systems and management factors in 12 Norwegian beef-cow herds (2003)

| Herd | Region | n | Housing system | Floor | Walking area | Resting area | Feeding area | Exercise yard | Days at pasture (cow/heifer) | Routine claw trimming |
|------|--------|---|----------------|-------|--------------|--------------|--------------|---------------|----------------------------|----------------------|
| A    | I      | 15 | Free stall     | Other | Solid        | Cubicles     | Solid        | Yes           | 66                         | No                   |
| B    | I      | 45 | Both           | Concrete | Slatted  | Cubicles     | Slatted      | Yes           | 118                        | No                   |
| C    | I      | 31 | Free stall     | Concrete | Slated  | Slated       | Slated       | No            | 165                        | No                   |
| D    | I      | 35 | Free stall     | Other   | Deep litter  | Deep litter  | Deep litter  | Yes           | 82/112                    | No                   |
| E    | I      | 21 | Free stall     | Other   | Deep litter  | Deep litter  | Deep litter  | Yes           | 77/213                    | No                   |
| F    | I      | 19 | Free stall     | Concrete | Slated  | Slated       | Slated       | No            | 122/127                   | No                   |
| G    | II     | 16 | Tie stall      | Concrete | Slatted  | Slatted       | Slated       | No            | 153                        | No                   |
| H    | II     | 33 | Free stall     | Other   | Deep litter  | Deep litter  | Solid        | Yes           | 364                        | No                   |
| I    | II     | 18 | Free stall     | Concrete | Slated  | Cubicles     | Slated       | No            | 364/144                   | No                   |
| J    | III    | 33 | Tie stall      | Concrete | Slated  | Slated*       | Slatted       | No            | 117/132                   | No                   |
| K    | III    | 17 | Free stall     | Concrete | Slated  | Cubicles     | Slated       | No            | 200/91                     | No                   |
| L    | III    | 79 | Free stall     | Concrete | Solid   | Cubicles     | Solid        | No            | 109                       | No                   |

* Mats of rubber used around calving

### Table 2: Feeding and feeding routines in 12 Norwegian beef-cow herds (2003)

| Herd | Region | n | Types of roughage feed | Concentrate heifers | Concentrate before calving | Concentrate after calving | Mineral or vitamin additives | Salt lick with minerals |
|------|--------|---|------------------------|---------------------|---------------------------|---------------------------|-----------------------------|-------------------------|
| A    | I      | 15 | Round bale grass silage, straw | Yes                 | No                        | No                        | Yes                         | Yes                     |
| B    | I      | 45 | Round bale grass silage, ammonia-treated straw | Yes                 | No                        | No                        | Yes                         | Yes                     |
| C    | I      | 31 | Grass silage, ammonia-treated straw, hay, round bale grass silage | Yes                 | Yes                      | Yes                      | No                          | Yes                     |
| D    | I      | 35 | Round bale grass silage | Yes                 | Yes                      | Yes                      | Yes                         | Yes                     |
| E    | I      | 21 | Round bale grass silage, ammonia-treated straw | Yes                 | Yes                      | Yes                      | No                          | Yes                     |
| F    | I      | 19 | Round bale grass silage | Yes                 | No                        | Yes                      | Yes                         | Yes                     |
| G    | II     | 16 | Grass silage, round bale grass silage | Yes                 | No                        | No                        | Yes                         | Yes                     |
| H    | II     | 33 | Grass silage, round bale grass silage | Yes                 | No                        | No                        | Yes                         | Yes                     |
| I    | II     | 18 | Grass silage | Yes                 | Yes                      | Yes                      | Yes                         | Yes                     |
| J    | III    | 33 | Round bale grass silage, ammonia-treated straw | Yes                 | Yes                      | Yes                      | Yes                         | Yes                     |
| K    | III    | 17 | Round bale grass silage, ammonia-treated straw, other | Yes                 | No                        | Yes                      | Yes                         | Yes                     |
| L    | III    | 79 | Round bale grass silage, ammonia-treated straw | Yes                 | Yes                      | Yes                      | No                          | Yes                     |
Two different unconditional logistic regression models were performed using the presence or absence of infectious and laminitis-related claw lesions as dependent variable, and age group (young = 2–4 years, medium = 5–7 years, old = ≥8 years) as independent variable (PROC LOGISTIC).

For animals that had been slaughtered within two years after claw inspection, general linear models (GLM) with carcass weight, conformation class and fat cover class as dependent variables were performed with "disorder" (presence of any claw or limb disorder, yes/no) as independent variable and breed as adjusting variable. The fit of the models was assessed by the R²-values.

At herd level, univariate statistics were generated for all environmental factors in relation to the occurrence of 1) claw and limb disorders, 2) laminitis-related claw lesions and 3) infectious claw lesions. For laminitis-related claw lesions, several of the environmental factors were statistically significant. All these factors were included as independent variables (fixed effects) in a preliminary multivariate (GLM) model with the herd prevalence of laminitis-related claw lesions as dependent variables.

Two-tailed tests were applied. The type III F-test was used as elimination criterion. The modelling was manually conducted by stepwise backward elimination of variables one by one, using a p-value of 0.05 as the level for exclusion from the model. The least square means were estimated for all levels of significant independent variables in the final model.

General linear model (GLM) with calving interval as dependent variable was performed using PROC GLM, with claw and limb disorders (yes/no) as independent variables and breed as adjusting variable.

Results

Prevalence of claw and limb disorders

Lameness was recorded in 1.1% of the animals, and only in hind limbs (Table 5). Pericarpal swellings were recorded in one animal. In total, claw and limb disorders were recorded in 29.6% of the animals, 4.1% with front and 28.2% with hind limb disorders, respectively.

Most claw lesions in front and hind claws were score 1. All together 20.6% of the lesions were score 2: Heel-horn erosions (20 out of 64 cases); sole ulcers (3 out of 6 cases) and dermatitis (3 out of 8 cases). Only one score 3 (heel-horn erosions) was recorded.

Infectious claw lesions including dermatitis and heel-horn erosions were recorded in 16.6% of the animals, varying from 0–58.2% on herd level, and laminitis-related claw lesions including haemorrhages in the white line and the sole, sole ulcers, white-line fissures and double soles were recorded in 18.0% of the animals, varying from 0–60.6% on herd level (Table 5 and 6). Infectious lesions were 9.8 times more frequent in hind claws than in front claws, whereas laminitis-related lesions were 7.6 times more frequent in hind claws. Laminitis-related claw lesions were recorded in 11 out of the 12 herds (92%), whereas infectious claw lesions were recorded in 4 out of 12 herds (33%). Vertical fissure and interdigital hyperplasia (corns) were both only recorded in one animal. Interdigital phlegmon, horizontal fissure and papillomatous dermatitis were not recorded in any animal.

Claw length and shape

The average front-claw length was 84 mm, varying from 61–100. Hind claws were 89 mm (67–102). Recordings of asymmetric and corkscrewed claws are in Table 4. Corkscrewed claws were mainly recorded in Charolais (10%)
and Limousine (15%). Asymmetric claws were mainly registered in Aberdeen Angus (23%), Limousine (15%) and Charolais (14%).

Effect of age and breed on claw lesions
The distributions of laminitis-related and infectious claw lesions related to age are in Figure 1 and the distribution of different laminitis-related lesions related to age is in Figure 2. There were more laminitis-related lesions in medium-aged (OR = 2.4, 95% CI 1.2–4.6) and old animals (OR = 4.8, 95% CI 2.3–9.8) compared to young animals (p < 0.0001). Infectious lesions were also more prevalent in older cows, and the corresponding numbers were 2.1 (1.1–4.2) and 3.3 (1.5–7.1) (p < 0.01). The distributions of laminitis-related and infectious claw lesions related to breed are in Figure 3.

Claw and limb disorders related to reproduction and carcass characteristics
The average calving interval was 366 days for cows with disorders, and 355 days for cows without, but the differ-
ence was not significant when adjusted for herd. The percentages of animals that were slaughtered one and two years after claw trimming were not significantly different between cows with and without disorders. Within the group of animals that were slaughtered within two years after claw trimming, the animals with disorders had on average a higher carcass conformation class (5.9) than the animals without disorders (4.8). The difference was, however, not significant after adjusting for breed. Carcasses from animals with disorders were on average 34 kg heavier than carcasses from animals without disorders, when adjusting for breed (p = 0.02), but had similar fat cover class.

Claw lesions related to environmental factors and management

None of the herd-level environmental factors was associated with the herd prevalence of claw and limb disorders. For laminitis-related lesions, several factors were significant when looked at separately (Table 7). However, only "region" remained in the multivariate model. For infectious claw lesions, the only significant factor was frequency of change and supplementation of litter in calf pens, with average prevalences of 0, 9 and 58% for "daily", "when needed" and "weekly", respectively (p < 0.01, R² = 0.65).

Discussion

Representativity and general discussion

Five months is a relatively long recording period for a cross-sectional study and might have biased our results. However, because of considerable climate differences between the three regions it was impossible to avoid trimming in different months with this study design. It was important for us to include three regions to achieve the largest possible study population.

Average herd sizes in our study were larger than the Norwegian average, but are probably representative for future beef-cow herd sizes in Norway. The study was part of a project where the main aim was to study claw health in dairy herds, and systematic errors caused by differences in claw-trimming practices and diagnosing of claw lesions are discussed by Sogstad et al. [15]. All claw trimmers in our study also participated in the study of dairy herds where a lack of cluster effect within claw trimmer (except for heel-horn erosions in front and hind claws and white-line fissures in front claws) indicated that agreement between trimmers was satisfactory. The recording protocol in this study was identical to the protocol in the dairy-herd study and results from our beef and dairy-cattle studies are compared below. Manske [22] found differences in recording among claw trimmers, and underreporting of mild and common lesions were marked. Underreporting might have biased our results, but we expect the most-important lesions to be recorded. There is probably an underestimation of lameness in the present study. It was

![Figure 2: Laminitis-related claw lesions related to age in 12 Norwegian beef-cow herds.](image-url)
I find the information on the page to be quite detailed and informative. It discusses various aspects of lameness in cattle, including the prevalence of lameness in different settings, causes of lameness, and the impact on animal health and veterinary services. The text also mentions the importance of maintaining good claw health and the factors that contribute to lameness.

The prevalence of lameness in beef-cow herds in the study was 26.6% for beef cows and 30.2% for dairy cows. The study also found that the prevalence of laminitis-related lesions was 1.1% for hind-limb lameness in beef-cow herds in Norway. Laminitis-related lesions are more common in dairy herds compared to beef herds, and there is a higher prevalence of lameness in free-stall dairy herds compared to tie-stall herds.

The study also highlights the importance of good claw health and the factors that contribute to lameness. For example, traumatic injuries and infections are important causes of lameness in cattle. The text also mentions the importance of good management practices, such as maintaining good claw health, to prevent lameness.

Overall, the study provides valuable insights into the prevalence and causes of lameness in cattle, and the factors that contribute to laminitis-related lesions. This information can be useful for veterinarians, farm managers, and researchers working in this field.
feedlots, it must be kept in mind that most of those herds consist of bulls on high-energy feeding whereas our herds were cows fed much roughage and small amounts of concentrates. More laminitis-related lesions in hind claws than in front claws in our study are in agreement with studies of dairy cattle [4,24,15]. Differences in claw shape, limb conformation, movement and shifting of weight make the hind claws more disposed [19], and hind claws are also more exposed to dirty environment.

The prevalence of haemorrhages of the white line and the sole was low compared to many studies of dairy cattle [32,33,30]. Sogstad et al. [15] found that 13.6% of hind feet in free-stall herds were affected by haemorrhages of the white line and 20% by haemorrhages of the sole. Lower prevalence of haemorrhages in beef-cow herds might be the result of low-intensity feeding. Greenough et al. [34] found that high-energy feed increased the prevalence of toe and heel haemorrhages in feedlot calves and heel haemorrhages in feedlot yearlings. External mechanical forces is also considered to cause claw-horn disruption and haemorrhages [16,35], but our material is too small and there is too much variation in housing and conformation systems for any conclusions on the influence of environment.

The prevalence of sole ulcers was also low compared to what has been found in most studies of dairy cattle [36,24] but approximately the same as in the Norwegian dairy cattle study. Sole ulcers are the result of haemorrhages and contusions in the corium leading to claw-horn disruption and possible infection [8]. Thysen [13] found that the prevalence of sole ulcers observed at claw trimming was not affected by the housing system, which is in agreement with Sogstad et al. [15]. This suggests that metabolic and hormonal factors are important in the pathogenesis of sole ulcers both in beef and dairy cattle.

White-line fissures being the most frequent laminitis-related lesion in our study partly agrees with Smith & Brodersen [37] who found that separation of the wall from the sole at the white line was the most frequent external lesion in lame feedlot cattle. Mülling [38] considered separation of the white line to be the result of weakening of the suspensory apparatus of the claw, haemorrhages, accumulation of exudates and impaired horn production, which again predisposes to infection. He also suggests that haemorrhages of the white line predispose to white-line fissures, but also that fissures might be caused directly by mechanical influences in the environment. The Norwegian dairy cattle study also indicated that direct mechanical influences including uneven forces from slatted concrete floors, is important for the development of white-line fissures [35]. Bad slats, narrow passageways, uncomfortable cubicles, overcrowding, increased com-
with increasing age [45-47,24,35]. This might be the result of repeated scarring of the corium with irreversible and cumulative damage to claw tissue [8]. More haemorrhages of the sole with increasing age are in contrast to many studies of dairy cattle which found highest odds for haemorrhages of the sole in primiparous cows [32,24,35]. Dairy heifers are experiencing major changes in housing conditions, social environment, nutrition and physiologic demands which might lead to increased prevalence of haemorrhages in first lactation. Because beef-cattle heifers do not experience such dramatic changes around calving, fewer laminitic lesions including haemorrhages of the sole can be expected. Stanek et al. [10] found that claw condition grew worse with an increase in body weight, and higher body weight with increasing age might partly explain the relation between more claw lesions and increasing age. Townsend et al. [48] found that lameness in 326 young beef bulls was associated with weight. They predicted that the odds of lameness in the animal with the heaviest initial test weight was approximately seven times greater than in the animal with the lightest initial test weight. Foot rot, laminitis and minor traumatic injuries were evaluated to be the most important causes of lameness in their study.

Townsend et al. [48] found relation between lameness and breed and explained this by differences in claw shape, size, conformation and horn composition of the different beef-cattle breeds. Small groups in our study make comparison of different breeds difficult. There were 72 animals of the Hereford breed and 97 Charolais. The prevalence of laminitis-related lesions was 11% and 49%, respectively. The herd effect might be responsible for most of the difference, but the prevalence for the Charolais breed is still rather high. For infectious claw lesions, Simmental had the highest prevalence with 45%. However, this number refers to only 15 animals from one herd, and should be interpreted with care. Almost all dairy cattle in Norway are Norwegian Red, and the effect of breed must be kept in mind when these beef-cow herds are compared to the dairy-cattle herds.

Claw and limb disorders related to reproduction and carcass characteristics

Longer calving interval in animals with claw and limb disorders versus animals without is in agreement with Sogstad et al. [23] who found associations between moderate and severe heel-horn erosions and sole ulcers and increased calving interval in dairy cattle. Cows with tender feet are more reluctant to walk, show less estrual activity and likely eat less than other cows. Barth & Waldner [49] found that lameness reduced the probability of satisfactory reproductive-soundness classification of beef bulls. Higher conformation class and increased carcass weight in animals with disorders versus those without can probably be explained by the breed differences. An unanswered question is why more cows of heavy than light breeds were slaughtered within two years of the claw inspection. Sogstad et al. [50] found that lameness and lesions at the tarsus in dairy cattle were associated with lower conformation class and lower carcass weight, whereas sole ulcers were associated with higher conformation class. Our results might be a direct consequence of more claw and limb disorders in heavy breeds. However, the results might also be influenced by most lesions being mild.

Claw lesions related to environmental factors and management

The small power in the study makes association between claw lesions and environment and management hard to detect. The relation between increased time at pasture for both cows and heifers and laminitis-related claw lesions was not expected because pasture usually is positive for claw health. However, if the animals are at pasture in winter, as they were in some herds, and the soil gets frozen, this might lead to increased external pressure on the claws. Muddy and frozen feed might also cause digestive disorders. The associations between the presence of isolated room for staff and available hot and cold water and laminitis-related lesions might indicate that management and attention indirectly influence claw health. "Region" probably remained in the model because some variables influencing on laminitis-related lesions were different in the 3 regions (Table 3). The distribution of both season for trimming and breed were skewed. It is not obvious how the recorded date for calving and age influenced our result. However, the herd with the highest prevalence of laminitis-related lesions, which was located in region II, also had a high mean age. Unfortunately the median date for calving in this herd was not reported and there might also be other unknown factors predisposing for laminitis-related lesions in this herd. Even though there was a lack of cluster effect within claw trimmer in our dairy-herd study we cannot exclude the possibility that different trimmers recording claw lesion might have biased the present result.

The variable "frequency of change and supplementation of litter in calf pens" is an indicator for the general hygienic level in the herds. Frequent change and supplementation of litter might have a direct preventive effect on infectious claw lesions, however, the investigated herd groups, cows and heifers, did not use these pens at the time of recording.

Conclusion

Our study shows that the prevalence of lameness was low in 12 Norwegian beef-cow herds compared to beef-cattle
herds in other countries and also that there were less claw and limb disorders in these herds compared to foreign dairy-cattle herds. Most claw lesions were mild, and the prevalence of lameness did not differ much from Norwegian dairy herds. Laminitis-related lesions were recorded in 18.0% and infectious claw lesions in 16.6% of the animals. White-line fissure was the most frequent laminitis-related lesion and heel-horn erosion the most frequent infectious lesion. Both laminitis-related and infectious claw lesions increased with age.

**Competing interests**
The author(s) declare that they have no competing interests.

**Authors’ contributions**
TF contributed to the design of the study. He taught the claw trimmers correct trimming and how to diagnose and record claw lesions. He also made the draft of the manuscript. ON who knows the beef-cow production very well, contributed to the design of the study and was the main coordinator. He also helped drafting the manuscript. BF performed the statistical and epidemiological analyses and also wrote the main part of the chapter “Material and methods”. GR visited the herds and recorded data on lameness. He also made the draft of the manuscript. All authors read the manuscript several times and approved the final manuscript.

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