Lameness and hock lesion prevalence in dairy cattle in Alberta

A comparison between 2011 and 2015

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Abstract

The aim of this study was to investigate if the prevalence of lameness and hock lesions on dairy farms in Alberta has changed between 2011 and 2015. Ten dairy farms were visited between April and May 2015 to collect the 2015 data. The selected farms had a milking herd of at least 100 milking Holstein Friesian cows. On each farm 40 cows were selected with a DIM between 1 and 120 and 20 cows with a DIM over 120. For the 2011 data 10 farms from a previous study were randomly selected. The lameness and hock lesion data of the 2011 farms was collected from the database. The cows were scored for lameness using a simplified Flower and Weary scale. Hock lesions were scored using a scale from 0-3. Lameness prevalence was 19% (SD 0.39) for the 2011 group and 27% (SD 0.45) for the 2015 group. The difference in lameness prevalence was significant (χ^2=8.371, p=0.004). The prevalence of hock lesions in 2011 (43%) was different from 2015 (47%)(p<0.001). There was no correlation between lameness and hock lesions on both legs in 2011 and 2015. The current study cannot explain the difference in lameness prevalence or hock lesion prevalence. Several factors that could account the difference are proposed. More research is needed to investigate whether these factors can explain the higher lameness and hock lesion prevalence in 2015.

Contents

Introduction

Lameness is a major health problem in freestall dairy farms. The prevalence of lameness differs between farms, resulting in a mean prevalence of lameness between 20 and 30 percent in freestall herds in North America.[1-3] Lameness has a negative impact on the welfare of cows. According to the World Organization for Animal Health (OIE) an animal is in good welfare if it is "healthy, comfortable, well nourished, safe, able to express innate behavior, and ... is not suffering from unpleasant states such as pain, fear, and distress".[4, 5] Lame cows have a lower nociceptive threshold, meaning lame cows have hyperalgesia. Hyperalgesia can be an indication of pain.[6] The presence of pain in case of lameness is also indicated in another study, which shows that the gait of lame cows improves after the administration of the NSAID ketoprofen®.[7] Therefore, lameness has, as stated above, a negative influence on animal welfare.

In addition to an impact on animal welfare, lameness also has an impact on dairy production. A reduction in milk production is commonly reported in current literature.[8, 9] The milk loss per lame cow is on average 360 kg per lactation, ranging between 160 and 550 kg.[8] High producing cows seem to be at higher risk for lameness. However, the milk yield often decreases to such an extent that a lame high producing cow will produce less milk than an average cow in a 305 day lactation.[8, 9] Lameness also has a negative impact on fertility.[9] A prolonged calving-to-conception interval has been shown in lame cows.[10] There are probably multiple reasons to explain this. One of those reasons is a 3.5 times higher risk on delayed ovarian activity in lame cows.[11] Other possible reasons include a higher risk of developing ovarian cysts, lower chance on ovulation and decreased signs of estrus in lame cows.[9] In 2007, a study was conducted to determine if farmers are more likely to cull lame animals. It became clear that severely lame cows had a 1.74 higher chance of getting culled.[12] The reason for this is not mentioned but it could be motivated by economic reasons. A Dutch study in 2010 estimated the lameness costs to be on average $95 per cow per year.[13] An estimated 22% of the economic loss is caused by reduced milk production. Other economic reasons are likely to be the treatment cost of lameness or fertility problems and labor costs of the farmers themselves.

Just like lameness, hock lesions are highly prevalent on dairy farms all over the world.[14-16] The hock lesion prevalence found in Canada in 2011 was 47%.[2, 17] Even though the hock lesion prevalence seems to be much higher than the lameness prevalence, frequently a correlation was reported between the two.[14-20] For example, Brenninkmeyer et al.[14] found a positive association between the absence of lesions and normal locomotion in cows and a significant correlation between high hock lesion and lameness prevalence. According to Solano et al.[20] cows on dairy farms in Canada have a 1.4 times higher chance to be lame. It is not known whether lameness results in more hock lesions or hock lesions increase the chance on lameness. However, since hock lesions and lameness do seem to be correlated, it would be interesting to see if the prevalence of hock lesions changed over the course of time and if said change is similar to the change in lameness prevalence.

Because of both the economic impact and the impact on animal welfare, lameness presents a big problem to dairy farmers. A study was conducted in Alberta, Canada (AB) in 2011 with two objectives. The first objective was to measure the lameness prevalence in AB. The second objective was to develop a tool to uniformly quantify risk factors for lameness in Canada. This study consisted of several methods to measure cow comfort and lameness. To measure cow comfort several cow and barn measurements like, lying time, hock lesions and bedding type were used. Lameness was measured as described in Materials and Methods. Based on the results of all the participating farmers, every participating farmer received feedback. This feedback consisted of their scores on risk factors in comparison to other farms, including the lameness prevalence in the herd. Benchmarking happened within the province and across the country. Overall lameness prevalence in this study was 20%.[21] This prevalence is one of the lowest recently measured in the North American region. Lameness prevalence was 24.6, 21.1 and 27.9% in Minnesota, Wisconsin and British Columbia (BC) respectively.[1-3] It is, however, comparable to the lameness prevalence of 20.6%, found in dairy cattle in England and Wales.[22] This might suggest that the lameness prevalence does not differ much over time or between different areas of the world. Unfortunately, the comparison of these numbers has limited relevance for lameness in Alberta because none of the studies are conducted in the same region.

The study presented in this report is part of the follow-up study of the 2011 Alberta study. Since the original study gave feedback to its farmers, the follow up study will be able to look at the influence of the feedback to producers on the prevalence of lameness and hock lesion on freestall dairy farms in AB. In order to do so, it is useful to know if any differences in both lameness and hock lesion prevalence have occurred on farms that did not enroll in the 2011 study. If changes in prevalence did occur, those changes were not influenced by the 2011 study. The changes would have occurred because of another reason. Therefore, looking at the lameness and hock lesion prevalence changes in farms that did not participate in 2011 will provide useful information when looking at the possible changes in those prevalences from farms which did participate in 2011 later on.

The objective of this study was therefore to determine the current prevalence of lameness and hock lesions in dairy farms that did not participate in the 2011 study, in Alberta in 2015, and evaluate if the prevalence in 2015 has changed relative to the prevalence in Alberta in 2011, using the lameness and hock lesion prevalence estimations of 2011 from a random selection of the farms that participated in 2011.

Materials and Methods

2011 data collection

The 2011 farms had to meet the same selection criteria as the 2015 farms. The only difference between 2011 and 2015 is the number of selected cows. In 2011 40 cows that were between 10 and 120 days in milk (DIM) were selected on each farm. Eighty farms were visited in 2011 that met the inclusion criteria, of those 80 farms 10 farms were selected using a simple random sampling method in SPSS 22.0. The 2011 group of this study consisted of the data collected in 2011 from the 10 selected farms. The lameness and hock lesion prevalence of the 2011 group was compared to the complete 2011 dataset to see if the selection was representative for the complete dataset. The difference between the prevalence from the complete dataset and the selection were compared using a binomial test.

Data Handling

The 2011 data were previously entered in the database used for that study and exported into Excel (Microsoft Corp.). These Excel data were used for the statistical analysis in SPSS 22.0.

2015 data collection

Farm selection and visits

Ten dairy farms were selected in Alberta (Canada) to participate in this research project as the 2015 group. Farmers who did not participate in the 2011 study, were asked if they would be interested in joining the research project. The first 10 farms that met the inclusion criteria were used for this study. The inclusion criteria for these farms were: 1) A milking herd with at least 100 Holstein-Friesian cows of which at least 60 are milked at the time of the study, and 2) the lactating herd is housed in a free stall barn and has access to exercise pens for a maximum of 2 hours a day. The criteria were chosen in order to make sure the selected farms would represent the majority of Alberta dairy farms. All farms in the 2015 group were visited once between the March 15 and May 30, 2015. They were visited around milking time either in the morning or the afternoon, based on the preference of the farmer. During the visits, videos were recorded for the lameness scoring while cows were exiting the parlor. Hock lesions were scored either in the milking parlor or pen. Furthermore, several other measurements were taken as part of the larger follow-up study.

Cow selection

On each farm 60 cows were selected. The cows were selected before going to the farm. Up to 40 cows between 10 and 120 DIM were selected from the herd. Cows with a DIM over 120 were selected until a total of 60 cows was reached. At least 20 cows over 120 DIM were selected to ensure wide range of DIM in the herd was covered by the study. Dry cows or cows that were in the sick pen during data collection were excluded from the study.

Lameness scoring

The selected cows were video recorded on farm while exiting the milking parlor. At least two full strides were recorded for each cow, as well as their unique identifier, which were called out loud when a cow passed by. Cows had to walk at a normal pace and in a straight line. The recordings showed the cow walking from the side. If a video did not meet the criteria the cow was excluded from the study. The videos were scored according to an adjusted scale based of the Flower and Weary scale.[23] Because of the amount of animals to be scored, a simplified version was used. The original scale measured 6 different traits (back arch, head bob, symmetrical gait, track-up, joint flexibility and weight baring/limping) based on which a lameness score of 1 to 5 was assigned. The simplified version only scores 3 traits and assigns a lameness score between 0-3. This scale was used in the 2011 study, which makes it possible to compare the lameness prevalence. The scoring of the lameness video's in 2015 was done by one observer. The scale scores three traits: asymmetric steps, limping and head bob. Each of these traits were either be absent (0) or present (1), as presented in Table 1. If a cow scored at least 2 points she was classified as limp.

Table 1. Classification of lameness scoring traits

Behavior	Absence	Presence
Head Bob	Even, gradual up and down head movement when walking.	Jerky or exaggerated up and down head movements when walking. Obvious when foot makes contact with ground.
Asymmetric steps	Hooves placement is in an even "1, 2, 3, 4" fashion	Uneven rhythm of foot placement "1, 2.....3, 4". Foot placement is not equal on both sides, cow places her hooves in an uneven rhythm.
Limping	All legs bear weight equally	Walk with an uneven, irregular, jerky or awkward step as if favoring one leg.

Hock lesion scoring

The cows that were selected for scoring were identified by their unique identifier. The selected cows were scored in the area with the best view on the hocks. Therefore the location depended on the type of milking parlor and the character of the cows. Most often cows would be scored in the pen, while the remainder were scored in the milking parlor. Both left and right hind leg were scored in the region shown in Figure 1.[17] The lesions were scored on a scale from 0-3, the criteria can be found in Table 2. This scoring system was also used in the 2011 study. The scoring of hock lesions in 2015 was done by one observer. Cows which scored 1 or higher were classified as positive for a hock lesion.

Figure 1. Location of the hock region[17]

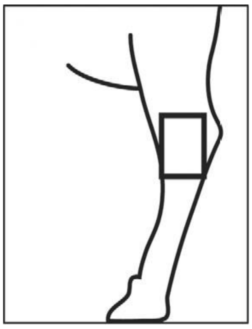


Table 2. Criteria for the hock lesion scoring scale

Region	Score 0	Score 1	Score 2	Score 3
Hock	No swelling. No hair is Missing, no broken hair.	Bald area on hock with no swelling or swelling <1 cm high.	Swelling 1–2.5 cm high, or broken skin or scab on bald area.	Swelling >2.5 cm high. May have bald area, broken skin, or scab.

Data handling

The data from the 2015 farms were entered into Excel (Microsoft Corp.). These Excel data were used for the statistical analysis in SPSS 22.0. One of the hock scores had to be available for the general hock lesion score. If both hock scores are available, the highest score was taken into account.

Statistical analysis

The determined sample size for this study was at least 572 animals, with a power of 0.90 and a significance of 0.05. Both the 2011 and 2015 group should therefore consist of at least 286 animals for every analysis. The number of selected farms was based on the number of animals needed and the risk of missing data due to difficulties with missing or incorrect unique identifiers and scoring and videotaping on farm.

All data used in this study were analyzed using SPSS 22.0. In total 3 different statistical analyses were done. The difference between lameness prevalence in 2011 and 2015 was compared using a chi-square test. The difference was considered significant if the P-value was < 0.05. A logistic regression was done to investigate if there was a significant influence of each farm on the lameness prevalence. The binary outcome variable was lameness and the separate farms were used as the categorical predictor variable. If there was a farm which had a significant influence, a chi-square test was done without that farm as a sensitivity analysis. The same statistical analysis as done for the lameness prevalence was used to compare prevalence of the hock lesions in 2011 and 2015. With the third statistical analysis the correlation between lameness and hock lesion scores was investigated. This was done for the 2011 and 2015 group separately. To test for these correlations a Pearson R data analysis was done, with a significance level of 0.05.

Results

The data from the 10 farms that were selected to provide the 2011 data, did not differ significantly from the complete 2011 dataset for lameness prevalence (p=0.14) or hock lesion prevalence (p=0.07). The selection was therefore considered representative for the complete dataset. The 2011 group consisted of 402 cows. On the 10 farms that formed the 2015 group, 559 of the 600 selected cows were included in at least one of the three analyses. The 41 cows excluded from the complete study did not have correct unique identifiers or the lameness and hock lesion scores were both absent.

Table 3. Description of the number of cows used for the lameness analysis, the lameness prevalence and the SD in the 2011 group

Farm number[1]	Number of Cows	Lameness prevalence (%)	SD
P1	38	13	0.343
P2	39	21	0.409
P3	32	28	0.457
P4	40	13	0.335
P5	38	13	0.343
P6	31	16	0.374
P7	34	29	0.462
P8	38	18	0.393
P9	30	27	0.450
P10	36	11	0.319
Total 2011	356	19	0.389

Analysis 1: Lameness prevalence

In total 852 lameness scores were analyzed, of which 496 represented the 2015 group and 356 the 2011 group. The number of cows per farm as well as the lameness prevalence and SD per farm can be found in Tables 3 and 4.

Table 4. Description of the number of cows used for the lameness analysis, the lameness prevalence and the SD in the 2015 group

Farm number[1]	Number of Cows	Lameness prevalence (%)	SD
N1	56	29	0.456
N2	37	8	0.277
N3	43	26	0.441
N4	57	23	0.423
N5	52	23	0.425
N6	49	14	0.354
N7	53	25	0.434
N8	40	38	0.490
N9	46	52	0.505
N10	36	36	0.487
Total 2015	469	27	0.445

The total number of lame and not lame cows for both the 2011 and 2015 group can be found in Figure 3. In Figure 2 the distribution of the lameness prevalence of all the farms is shown; the 2015 group farms had a higher lameness prevalence, especially farm N9, than the 2011 group farms. The lameness prevalence of the complete 2015 group was 27% (SD 0.45), the prevalence of the 2011 group was 19% (SD 0.39), this difference was significant (χ^2=7.766,p=0.005).

Figure 2. Distribution of lameness prevalence per farm

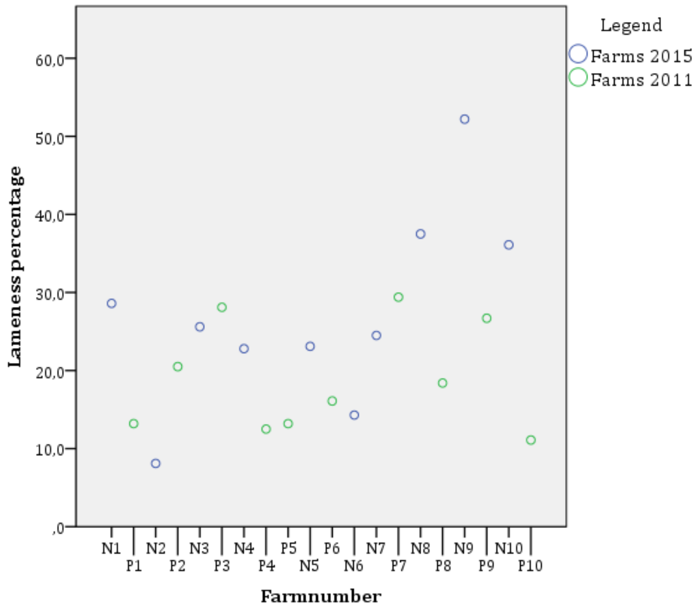
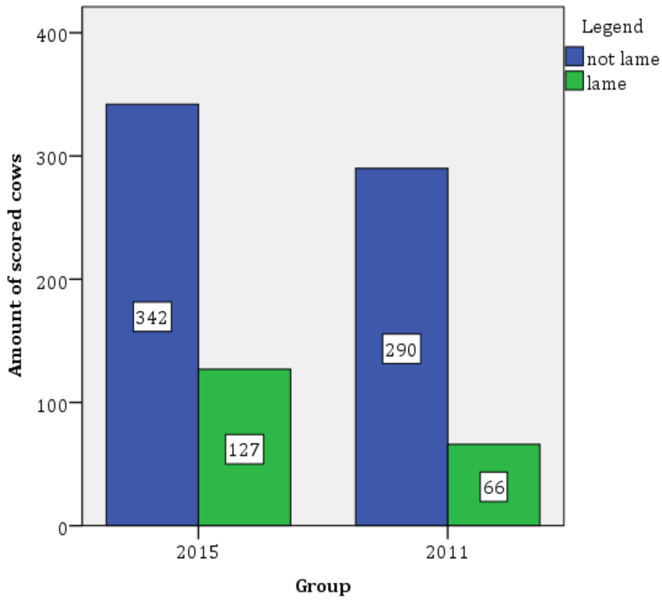


Figure 3. Number of lame and not lame cows for both groups



The logistic regression showed a significant influence of one farm on the lameness prevalence (P=0.03). The farm in case is N9, the chance of lameness was 3 times higher than on other farms. The complete results of all the farms can be found in attachment 1.

The chi-square test without farm N9, done as a sensitivity analysis, shows a non-significant difference between the lameness prevalence on the 2011 and 2015 farms (χ^2=3.507,P=0.061)

Analysis 2: Hock lesions

The 2015 group consisted of 1052 hock scores while the 2011 group consisted of 577 hock scores. In total 1629 hock scores were included in this analysis. . The number of cows per farm as well as the hock lesion prevalence and SD per farm can be found in Tables 5 and 6.

In Figure 5 the total number of cows with and without hock lesions is presented. The hock lesion prevalence seemed to differ a lot between the farms, as can be seen in Figure 4. Overall hock lesion prevalence was 56% (SD=0.50) for the 2015 group and 43% (SD=0.49) for the 2011 group; this is a significant difference (χ^2=24.355,p<0.001).

Table 5. Description of the number of cows used for the hock lesion analysis, the lameness prevalence and the SD in the 2011 group

Farm number[1]	Number of Cows	Hock lesion prevalence (%)	SD
P1	35	9	0.284
P2	79	70	0.463
P3	79	15	0.361
P4	71	49	0.504
P5	80	53	0.503
P6	39	49	0.506
P7	77	56	0.500
P8	40	25	0.439
P9	37	27	0.450
P10	40	48	0.506
Total 2011	577	43	0.495

Table 6. Description of the number of cows used for the hock lesion analysis, the lameness prevalence and the SD in the 2015 group

Farm number[1]	Number of Cows	Hock lesion prevalence (%)	SD
N1	113	52	0.502
N2	106	69	0.465
N3	98	60	0.492
N4	120	10	0.301
N5	117	74	0.439
N6	106	51	0.502
N7	105	60	0.492
N8	88	44	0.500
N9	115	83	0.381
N10	84	56	0.499
Total 2015	113	52	0.502

Figure 4. Distribution of hock lesion prevalence per farm

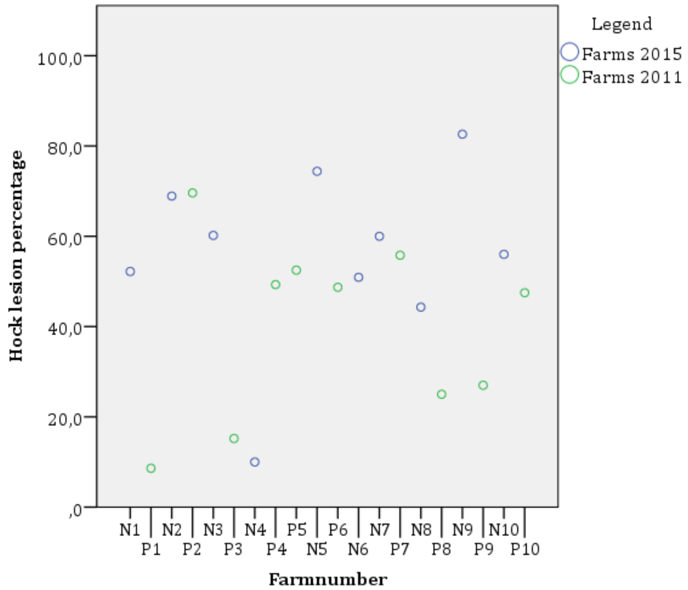
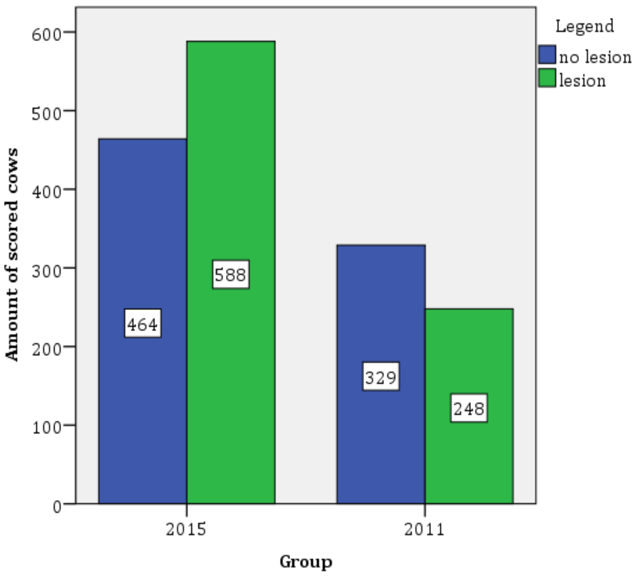


Figure 5. Number of cows with and without hock lesions for both groups



The logistic regression test showed that 9 farms had a significant influence on the overall hock lesion prevalence. On 5 of the farms there was a lower chance of hock lesions, on the other 4 a higher chance. Table 7 shows the P-values and Odds ratio of these farms, the complete table can be found in attachment 2. The sensitivity analysis did not show any differences in significance for any of the 9 farms found with the logistic regression.

Table 7. The P-value and Odds-ratio of the logistic regression for all farms with a significant difference

Farm number	P-value	Odds-ratio
N3	0.000	0.102
N4	0.001	2.654
N8	0.000	4.347
N9	0.000	0.086
N10	0.012	2.025
P3	0.000	0.164
P8	0.004	0.305
P9	0.009	0.339
P10	0.016	2.097

Analysis 3: The correlation between lameness and hock lesions

To analyze if a correlation is present between lameness and hock lesions, both hock lesion and lameness scores need to be available from the same cow. Both lameness scores and hock lesion prevalence were available for 439 cows for the 2015 group. In the 2011 group 340 cows had both measurements available.

The Pearson r data analysis for the 2015 shows a positive correlation between the hock lesions in general and lameness with $r = 0.076$. However this is not significant ($P=0.113$). Which means that there is no correlation between lameness and hock lesions in cows in this study. The Pearson r^2 data analysis for the 2011 group showed no significant correlation between hock lesions and lameness ($r=-0.054$, $P=0.323$).

Discussion

Data collection methods

There are several different methods available to gait score cows, however most of the manual methods have low or inconsistent inter and intra-observer scores.[24] The Flower and Weary scale shows relatively consistent and high scores on inter and intra-observer scores, which is also the case for the simplified version used in this study. [25-27] The actual intra-observer score in this study is 87.5%. For a gait scoring method this is relatively high and shows that the 2011 and 2015 scores can be compared without rescoring the 2011 data by the 2015 observer. The method used to score hock lesions also has high inter and intra-observer repeatability for trained observers.[25] The intra-observer score was 97%, scored on a farm when both the 2011 and 2015 observer were present.

Lameness Prevalence

The lameness prevalence in 2015 was significantly different from the lameness prevalence in 2011. The logistic regression test showed one farm in the 2015 had a significant influence on the lameness scores in comparison to the rest of the farms. The influence of farm N9 results in a significant difference, as shown with the sensitivity analysis; without N9 there is no significant difference. This higher influence on the data is not enough to exclude the farm from the data, in this case it means the farm stands out due to a high lameness prevalence in comparison to the rest of the farms. To exclude data, there would have to be evidence that the collected data is truly aberrant, or that there has been a mistake in the data collection. There were no problems with the lameness scoring on this farm. Farm N9 does have a high lameness prevalence with 52% it is much higher than the other farms. However wide ranges of lameness prevalence on farms have been shown in several other studies.[1, 3, 21, 22] Therefore there does not seem to be a good reason to exclude the farm from the data. In conclusion, the lameness prevalence has significantly risen in 2015 in comparison to 2011 on Alberta farms; although the significant difference is caused by farm N9. Between 2011 and 2015 all farms could have been more exposed to information about lameness, for example through Alberta Milk Meeting. However, the farms which participated in the 2011 study did receive specific feedback on their situation from the study. This might have had an extra influence on their lameness prevalence and the result is therefore not applicable to farms which participated in 2011.

It is not known why the lameness prevalence has changed between 2011 and 2015. The wide range in lameness prevalence, as seen in several studies, seems to suggest on-farm risk factors have more influence on lameness prevalence then factors from outside.[3] On-farm risk factors are the factors that can be found on the farm itself, like stall size. Risk factors from outside, like government regulation are not on the farm, but can influence it. Different on-farm risk factors have been associated with lameness prevalence on farms. According to Cook[3] bedding has an influence on lameness prevalence. In his study sand bedding gave a lameness prevalence of 21.2% compared to a prevalence of 33.7% for farms with matrasses. Similar results were found by Espejo et al.[1] in 2006. Espejo et al.[1] also found a high lactation number to be associated with lameness as well as a high milk yield. This association was also found in earlier studies.[8, 28] A poor body condition score (BCS) has also been associated to lameness in several studies.[1, 29] It has been proposed that lameness is the causative factor for a low BCS due to a lower feed intake of lame cows.[29] Which is supported by the fact that lame cows will feed up to 13 minutes less per day.[30] Another factor of which the results present consistent association is parity.[1, 20] Hock lesions are also described to have an association with lameness in certain studies and an increase in hock lesion prevalence could therefore help explain the higher lameness prevalence, if this is the case will be described later on in the discussion. DIM is a factor of which less consensus is reached. Espejo[1] reports no association exists between the month of lactation and lameness prevalence. While other studies do report a relation between DIM and lameness prevalence, the results are quite different. For example Rowlands[31] reports lameness is most common in the first month of lactation, while results from farms in Canada show a small increase in lameness prevalence with increasing DIM up to 120 days.[20] The reason for these different findings is not yet clear, however different management practices in Canada could be the reason. Only herds where the milking cows were not on pasture were included in the study done in Canada[20] because this is common practice. In Rowlands[31] study cows had access to pasture while in the milking herd. Cows that spent more time on pasture are less likely to be lame, so the extra time might prevent them from lameness later on in lactation. This would explain the difference between Rowlands[31] and Solano et al.[20] It is not known if the increased lameness with a higher DIM persists over a 120 DIM, because the cows were selected to have a DIM between 10 and 120, if possible.[20] If the lameness prevalence in Canada does indeed with increase with DIM above 120, this could be the explanation for the increase of lameness in 2015 since 20 cows with a DIM over 120 were selected in this study as well as 40 cows with a DIM between 10 and 120. However, since the DIM data were not entered into the database at the time of this study, it is difficult to determine the influence of the DIM with certainty.

Even though on-farm factors are likely to influence the lameness prevalence the most, the difference between lameness prevalence is apparent between the 2011 and 2015. It could be that all the farms with high lameness prevalence, regardless of the reason for this, are simply in the 2015 group by chance, while the 2011 group by chance only got the best farms. The 2011 group was representative for the whole 2011 study, which consisted of 80 farms. However the 2015 group contains only 10 farms which is a very small portion of Alberta's dairy farms. So although the 2011 group might be representative, the 2015 group could by chance have the farms with high lameness prevalence.

If a farm meets the inclusion criteria, ultimately it is the farmer who decides whether or not they will participate in a study. Farmers who participated in the 2011 study might have had a different motivation for joining than the farmers that participated in 2015. Farmers, like all people, tend to tell each other about their experiences. However the study in 2011 was the first of its kind in Alberta, farmers in 2011 would have had little reason to participate based on stories of other farmers. The farmers in 2011 might have participated because they perceived a specific problem, lameness for example, and were trying to solve this or because they were what is called the early adopters. The 2015 farmers might have decided to participate based on good experiences of other farmers instead, caring less about the actual purpose and outcome of the study.

Hock lesion prevalence

The hock lesion prevalence in 2015 is significantly different from the lameness prevalence in 2011. The prevalence found in 2015 is also higher then hock lesion prevalence found in other studies in Canada.[2, 17] As with the lameness prevalence scores, a logistic regression test was also done to look for any farms that influenced the hock lesion scores. Multiple farms from both the 2015 and 2011 group showed a significant influence on the hock lesion scores. The reason for this is the way the logistic regression test is set up. To compare the farms to the hock lesion scores the logistic regression test compares the results of all the farms in the group to the results of one of the farms. If a farm influences the hock lesions scores significantly different from the selected farm, it is that difference which is shown as an influence. This is the reason it should always be checked if the selected farm has a reasonable amount of data and is average for the whole group. The selected farm was checked, however the hock lesion prevalence in both the 2011 and 2015 farms shows a very wide range. The range for the 2015 group is 10-83% and the range for the 2011 group is 9-70 percent. Wide ranges are not abnormal for hock lesion studies, in studies with more data a range between 0-100% is often found.[2, 14] With this range it would not surprising that even in comparison to an average farm in the group, farms in both the lower and upper-range show a significant higher influence on the hock lesion scores. The results show that this is the case, 4 farms have a positive influence on hock lesion scores. While the other 5 farms show a significant negative influence. Therefore the result is the logistic regression test is understandable, but not a reason to exclude the data.

The question remains why the hock lesion scores have risen between 2011 and 2015. As with the lameness prevalence the reason cannot be determined from the data is the present study. Several on-farm factors have been associated with hock lesions. For example the base of the free stalls and the used bedding have a correlation with hock lesions. Farms with mattresses have a lower hock lesion prevalence then free stalls with rubber mats.[15, 32, 33] While farms which used more than 10 cm sand bedding on a concrete base show even lower hock lesion prevalences then mattresses in several studies.[14, 17, 18, 34-36] According to 2 studies a high milk yield and big herd size both increase the risk of hock lesions.[18, 37] Rutherford et al.[37] also found lactation number to have a negative influence on hock lesions. A positive factor seems to be the length of the stall, longer stalls are associated with lower hock lesion prevalence.[14, 17, 18, 35] Kielland et al.[15] however found that stalls with a length of more than 260 centimeter increased the hock lesion prevalence. There are several factors of which there is no consensus about their influence on hock lesion prevalence. The absence of a curb was found have a positive influence on hock lesions by Fulwider et al.[35], however Brenninkmeijer et al.[14] found a negative effect on hock lesions if the curb was absent. The reason proposed to explain this difference was the length of the stall. If a cow would barely fit in a stall her hock would likely lay on the curb, providing pressure on the hock.[14] Other examples of factors that might have a positive or negative influence on hock lesions are a high BCS and Cleanliness.[15, 17, 18] In contrast to lameness several studies find a high DIM is associated with increased hock lesions.[15, 18] Or that a low DIM gives reduced odds for hock lesions.[17] The reason for this is probably that dry cows are often housed on bedding packs or have extra outdoor access. This way of housing gives less hock lesions and gives old lesions time to heal. The more days she spends in the freestalls the higher the chance on a hock lesions might be, because for example a low amount of bedding. Because cows are returned to the freestall pen after giving birth, the amount of days in the freestall pen is approximately the same as DIM, explaining the increase o hock lesions with increasing DIM. As mentioned before, on the 2015 farms extra cows were selected with a DIM above 120, while the 2011 cows were all selected between 10 and 120 DIM. The cows with the higher DIM could have had more hock lesion scores explaining the difference in hock lesion prevalence between 2015 and 2011. All the other mentioned factors could, on their own or combined, also account for the difference in hock lesion prevalence between 2011 and 2015. The measurements of these factors are however not known at the time of this study. As with the lameness prevalence the potential reason why the farms in 2015 have a high hock lesion prevalence overall could be influenced the motivations to participate in the research project.

The correlation between lameness and hock lesions

For the 2015 group the correlation between hock lesions in general and lameness is not significant. Several other studies were not able to find a correlation between lameness and hock lesions as well.[17, 20] However, in those cases higher odds of hock lesions for lame cows have been found.[17] There are also studies that have found a correlation between hock lesions and lameness, although the correlation was often small.[14, 15, 18] Since lameness and hock lesions share several potential risk factors, it is not known if the correlation is also causative. It does seem to be the case that more severe hock lesions have greater odds for lameness.[18] This result could explain the lack of a correlation in the present data, to measure hock lesions all lesions were taken into account, which means that a cow with just a bald spot adds the same weight to the data as a cow with ulceration, both were in the end scored with a 1. So while there is no correlation between hock lesions and lameness there might be a correlation between severe hock lesions and lameness.

As mentioned before the absence of a correlation between hock lesions and lameness has been found before and might in this case be due to the scoring of the hock lesions. For the 2011 group no correlation between lameness and hock lesions could be found, this is consistent with results of the complete 2011 dataset[20]. One possible explanation for the absence of the correlation could be the lying time. As mentioned before hock lesions are associated with the bedding, length and curb of the stalls. Lying down in a stall for a longer period of time can therefore cause hock lesions. According to several studies a longer lying time can be caused by lameness.[38, 39] However longer lying times are also found in healthy cows when they have a high DIM, a higher lactation number or their milk production is high.[40, 41] There is a chance that the 2011 group had a longer lying time which was not due to lameness. This could result in more hock lesions which do not have a correlation with lameness. Because there is no correlation between lameness and hock lesions in both 2011 and 2015, the higher lameness prevalence cannot be explained by the higher hock lesion prevalence.

Conclusion

The objective of this study was to determine the current prevalence of lameness and hock lesions in dairy farms, which did not participate in the 2011 study, in Alberta in 2015 and evaluate if the prevalence has changed relative to the prevalence in Alberta in 2011. The expectation was that lameness prevalence would not be significantly different from 2011. However a lower lameness prevalence could be expected because the dairy industry showed more interest for the topic the past years. The general results of the 2011 have also been presented to the dairy farmers in general, giving them the opportunity to learn from the results.

The current lameness prevalence is 27%, which was significantly different from the lameness prevalence in 2011. Because the significant difference is caused by one farm, more research is needed to see if lameness prevalence has truly increased in the past years. The current hock lesion prevalence of 56% was also significantly different from the hock lesion prevalence in 2011. Although other studies do present either a correlation between lameness and hock lesions or higher odds of lameness if a hock lesion is present, neither was the case for both the 2015 and 2011 group in this study. Therefore the increase of lameness prevalence cannot be explained by the higher hock lesion prevalence for this study.

Besides the correlation between lameness and hock lesions the current study did not look for risk factors which could influence the lameness prevalence. Neither was any research done to identify factors which influence hock lesion prevalence. Several factors which could contribute to the difference have been mentioned. The probable difference in DIM, due to different selection criteria for the cows, between the 2011 and 2015 group could account for the higher lameness and hock lesion prevalence. This is only the case if the relation between lameness and DIM in Canada is indeed different from other parts of the world, due to the differences in housing system. More research is needed to see if this is the case in Alberta and to see if any of these factors explain the difference in lameness or hock lesion prevalence.

Since the study presented here is a small part of the larger follow-up study, more measurements on both cow and herd level were collected and will be collected on extra farms. Analysis of these measurements may provide a reason for the prevalence differences found here and will give a better understanding which factors influence lameness and hock lesions in dairy cows in Alberta. This knowledge could help find methods to lower the lameness and hock lesion prevalence and thus improving animal welfare on farms.

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Attachtments

1. Table with the logistic regression test for lameness

Results of the logistic regression test comparing lameness scores for all the farms

	B	S.E.	Wald	df	Sig.	Exp(B)
All Farms			45.143	19	0.001	
N1	0.095	0.508	0.035	1	0.851	1.100
N2	-1.416	0.730	3.761	1	0.052	0.243
N3	-0.056	0.541	0.011	1	0.917	0.945
N4	-0.208	0.520	0.160	1	0.690	0.812
N5	-0.192	0.528	0.133	1	0.716	0.825
N6	-0.780	0.581	1.805	1	0.179	0.458
N7	-0.112	0.522	0.046	1	0.830	0.894
N8	0.501	0.526	0.905	1	0.341	1.650
N9	1.099	0.508	4.686	1	0.030	3.000
N10	0.441	0.539	0.669	1	0.413	1.554
P1	-0.875	0.633	1.912	1	0.167	0.417
P3	-0.343	0.572	0.359	1	0.549	0.710
P4	0.073	0.570	0.017	1	0.898	1.076
P5	-0.934	0.632	2.188	1	0.139	0.393
P6	-0.875	0.633	1.912	1	0.167	0.417
P7	-0.637	0.639	0.992	1	0.319	0.529
P8	0.136	0.559	0.059	1	0.807	1.146
P9	-0.476	0.588	0.657	1	0.418	0.621
P10	-1.068	0.672	2.524	1	0.112	0.344
Constant	-1.012	0.413	6.004	1	0.014	0.364

2. Table with the logistic regression test for hock lesions

Results of the logistic regression test comparing hock lesion scores for all the farms

	B	S.E.	Wald	df	Sig.	Exp(B)
All Farms			210.945	19	0.000	
N1	0.151	0.289	0.271	1	0.603	1.163
N2	0.325	0.279	1.357	1	0.244	1.385
N3	-2.286	0.358	40.799	1	0.000	0.102
N4	0.976	0.283	11.867	1	0.001	2.654
N5	-0.051	0.271	0.035	1	0.851	0.950
N6	0.317	0.274	1.336	1	0.248	1.373
N7	-0.317	0.286	1.231	1	0.267	0.728
N8	1.470	0.310	22.498	1	0.000	4.347
N9	-2.456	0.632	15.074	1	0.000	0.086
N10	0.705	0.282	6.261	1	0.012	2.025
P1	-0.189	0.368	0.262	1	0.609	0.828
P3	-1.808	0.366	24.454	1	0.000	0.164
P4	-0.117	0.303	0.148	1	0.700	0.890
P5	0.012	0.293	0.002	1	0.969	1.012
P6	-0.140	0.372	0.142	1	0.707	0.869
P7	0.146	0.297	0.243	1	0.622	1.158
P8	-1.187	0.411	8.349	1	0.004	0.305
P9	-1.082	0.415	6.784	1	0.009	0.339
P10	0.741	0.309	5.756	1	0.016	2.097
Constant	0.089	0.188	0.221	1	0.638	1.093

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