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Estimated prevalence of lameness in 53 Northwest US dairy herds

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Abstract

Lameness is an important disease that can be quantified subjectively by locomotion scoring. The prevalence of lameness in dairy cattle has been measured in some areas of North America, but has not previously been measured in the northwest United States. In this study, 53 dairy farms in Washington and Oregon were visited, and herd lameness prevalence was estimated by locomotion scoring (using a 5-point system) using a systematically obtained sample of the lactating herd, distributed across the lactating cow pens. Over all herds, the prevalence of any gait abnormality was 21%, and just over 4% for cows that limped or refused to bear weight. Jersey herds had lower prevalence than Holstein herds, and the eastern part of the region had lower prevalence than the western part of the region. Estimating lameness prevalence on dairy farms can serve as a point of comparison or starting point for making herd and regional progress.

Key words: dairy, lameness, prevalence

Résumé

La boiterie est une importante maladie qui peut se quantifier subjectivement avec des indices de motricité. La prévalence de boiterie chez les bovins laitiers a été mesurée à quelques endroits en Amérique du Nord mais n'a pas été mesurée préalablement dans le nord-ouest des États-Unis. Dans cette étude, 53 fermes ont été visitées à Washington et en Oregon. La prévalence de boiterie a été estimée avec un indice de motricité (sur une échelle à 5 catégories) en utilisant un échantillon obtenu systématiquement à partir des différents enclos de vaches en lactation dans un troupeau. Sur l'ensemble des troupeaux, la prévalence de toute démarche anormale était de 21%. Il y avait 4% des vaches qui boitaient ou qui refusaient de supporter leur poids. La prévalence était moins élevée chez les troupeaux de vaches Jersey que chez les troupeaux de vaches Holstein. La partie est de la région avait aussi une plus faible prévalence que la partie ouest. L'estimation de la prévalence de boiterie dans une ferme laitière peut servir de point de référence ou de point de départ pour l'amélioration du troupeau ou de la région.

Introduction

Lameness affects dairy cattle welfare and productivity because it causes pain,[6,12] decreased milk production,[9] decreased reproductive efficiency,[10] and results in direct treatment costs to the producer.[3] Since lameness prevalence depends on both the incidence and duration of lameness-causing diseases in the herd, estimation of prevalence can be useful for benchmarking, auditing, and herd-level assessment to determine the scope of the problem and track improvements.

North American dairy herd lameness prevalence has been measured using cross-sectional locomotion scoring by an independent observer in previous studies,[4,7,14,16] but these data are limited to certain areas of the country. One study[14] measured lameness prevalence in a portion of cows (high-production groups) within 121 herds in 3 regions, and found average prevalence of clinical lameness to be 30% in British Columbia and California, and 55% in the northeast United States. In the same study, the average prevalence of severe lameness was 4% in California and 8% in British Columbia and the northeast United States. Another study[7] measured lameness prevalence in the high-production group of 53 free-stall housed herds in Minnesota. The average prevalence of lameness was 24.6% (ranging from 3.3 to 57.3%), and prevalence of severe lameness was 6%. Cook[4] locomotion scored all lactating cows in 30 free-stall and tie-stall housed herds in Wisconsin. Average lameness prevalence was 23.9% in winter and 21.1% in summer. In the winter, free-stall herds with non-sand stall surfaces had higher lameness prevalence (33.7%) than herds with sand stall surfaces (21.2%). Wells et

al[16] assessed lameness in primarily tie-stall herds and found a lameness prevalence of 13.7% in the summer and 16.7% in the spring.

Herd lameness prevalence has not been reported in the northwestern United States. The objective of this study was to estimate the herd level lameness prevalence in dairy herds in the states of Washington and Oregon. The data were collected as part of a Washington State University Veterinary Medical Extension dairy lameness reduction project, the goal of which was to raise producer awareness about lameness prevalence in their herds and make resources available to aid in herd problem investigation for lameness-causing diseases.

Materials and Methods

The sample size to estimate lameness prevalence in the region was calculated to be 57 herds, based on a population of 800 farms (approximately 450 herds in Washington State and 350 in Oregon) with an expected prevalence of 20% lameness, expected error of 10% and level of confidence at 95%. Herds volunteered for participation based on a mailing to Washington and Oregon licensed dairies, and an electronic mailing to dairy practitioners in Washington and Oregon listed in the American Association of Bovine Practitioners member directory. Any dairy herd in Washington or Oregon that volunteered to participate was included in the study. Prevalence of lameness in each herd was determined by locomotion scoring a sample of lactating cows based on a tested sampling strategy[11] in which a sample size is calculated and weighted by the number of cows per group or pen, and cows are selected in a distributed fashion across each group. For 5 herds, locomotion score data were available for a larger number of cows due to their inclusion in a previous study.[11]

Cows were assigned a locomotion score (LS) by a researcher, research assistant, or the herd's veterinarian. Participating veterinarians submitted LS data by mail, fax, or online form. A given cow was locomotion scored by only 1 individual. All individuals who performed the locomotion scoring completed the same online training module[a] with 12 videos of cows to score for the comparisons among raters. The locomotion scoring system was based on Sprecher et al,[13] where LS 1 indicates a sound cow with a level back walking and standing, LS 2 indicates a cow with an arched-back posture while walking but not while standing, LS 3 indicates the cow maintains an arched-back posture walking and standing, and additionally short-strides 1 or more legs, LS 4 indicates the cow additionally has reduced weight bearing on at least 1 limb, and LS 5 indicates refusal to bear weight on a limb. In the present study, it was not always possible to observe cows standing, so the presence or absence of short-stride gait was utilized to distinguish a score 2 from a score 3 in a cow that walked with an arched back. Cows were locomotion scored while freely walking in their pens or while walking to or from the milking parlor. Therefore, footing was variable and was either concrete (freestall pens, alleys, milking parlor exit lane) or dirt (open-lot pens).

Two definitions of lameness were used for analyses, LS $\geq$ 3 and LS $\geq$ 4. Inter-rater agreement was quantified using Randolph's free marginal multi-rater kappa[15] for agreement in 3 different ways: for the 5-category locomotion score, 2 category lameness at a cutoff of LS $\geq$ 3, and 2 category lameness at a cutoff of LS $\geq$ 4.

For the purpose of comparison, farms were grouped by area, breed of cows, and size. Area groups were east and west, based on location relative to the Cascade mountain range. Breed groups were Holstein, which were entirely Holstein herds; Jersey, which were entirely Jersey herds; and cross, which included herds with any combination of Holstein, Jersey, and Holstein-Jersey cross-breed cattle. Size groups were those with > 500 lactating cows, and those with $\leq$ 500 lactating cows.

Descriptive statistics were calculated using a computerized spreadsheet program[b]. Means of herd prevalence stratified by groups were compared with ANOVA using statistical software[c]. Statistical significance was defined as $P < 0.05$, and trend defined as $P < 0.1$.

Results

Interobserver Agreement

There were 10 total observers: 5 herd veterinarians, 3 researchers, and 2 research assistants. There were 2 herd veterinarians for which interobserver agreement LS data were not submitted after completion of the locomotion scoring training. Each of these veterinarians locomotion scored 1 herd. The 8 observers for which agreement data were available therefore accounted for 96% (51/53) of herd observations. Free-marginal kappa multi-rater agreement for the 5-category LS rating was 0.431. Only 4 of 96 total ratings were different from other ratings for a given cow video by more than 1 locomotion score, a 95.8% near agreement. For 2 category lameness ratings with lameness defined as LS $\geq$ 3, free-marginal kappa was 0.798. For 2 category lameness ratings with lameness defined as LS $\geq$ 4, free-marginal kappa was 0.762.

Lameness Prevalence

Fifty-three herds were enrolled in the study. Herd size varied from 93 to 5,159, with a mean of 1,040 and a standard deviation of 1,143. There were 25 small herds ($\leq$ 500 lactating cows) and 28 large herds (> 500 lactating cows). The number of cows locomotion scored per herd ranged from 51 to 2,374, with an average of 159 cows. Overall lameness prevalence was 19.1% for LS $\geq$ 3 and

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4.3% for cows with reduced or non-weight bearing gaits (LS ≥ 4) (Table 1). Just over 15% of herds had a lameness prevalence (LS ≥ 3) of less than 11%, while most (39.6%) of the herds had a prevalence between 11 and 20%, and about 17% had a prevalence over 30% (Figure 1). For lameness in which weight bearing on a limb was obviously reduced (LS ≥ 4), most (72%) of the herds had a prevalence of 0 to 5% (Figure 2).

There were 29 Holstein herds, 6 Jersey herds, 17 herds with a combination of Holsteins, Jerseys, and/or Holstein/Jersey cross cattle, and 1 herd for which breed was not reported. Mean prevalence of LS ≥ 3 was lower for Jersey herds compared to Holstein herds and crossbreed herds ($P < 0.05$), but no differences were detected between breeds for mean prevalence of LS ≥ 4 (Table 2). The 19 herds located east of the Cascade Mountains had a lower prevalence of LS ≥ 3 and LS ≥ 4 than the 34 herds in the western part of the region ($P < 0.05$). There were no differences in mean prevalence by herd size for LS ≥ 3 ($P = 0.6$), but there was a trend for herds with greater than 500 cows to have a lower mean LS ≥ 4 prevalence than herds with fewer than 500 cows (3.2% and 5.7%, $P = 0.06$). However, when herd size was stratified by area there were no differences in prevalence between herd size groups ($P = 0.6$).

Discussion

In the present study, prevalence of lameness was estimated for 53 dairy herds in the northwest United States. The mean prevalence of lameness was lower than the mean lameness prevalence described in British Columbia, California, and the northeast United States[14] for lameness and severe lameness (LS ≥ 4, decreased weight bearing on a limb or non-weight bearing), except severe lameness in California was the same as that in the present study. Mean lameness prevalence in the present study was similar to that found by Cook[4] and Espejo et al,[7] but mean severe lameness prevalence was higher than that of Cook[4] and lower than that of Espejo

Table 1. Mean, minimum, maximum, and quartile values for prevalence of locomotion score (scores 1-5), lameness prevalence defined as locomotion score ≥ 3, and lameness defined as locomotion score ≥ 4 in 53 dairy herds.

	Prevalence						
	Locomotion score					Lameness	
	1	2	3	4	5	LS ≥ 3	LS ≥ 4
Minimum	11.6%	20.0%	2.8%	0.0%	0.0%	3.0%	0.0%
25th percentile	29.5%	38.0%	11.8%	1.2%	0.0%	14.6%	1.2%
Mean	37.2%	42.7%	16.8%	4.3%	0.04%	21.1%	4.3%
75th percentile	43.0%	48.6%	20.9%	5.6%	0.0%	24.4%	5.6%
Maximum	70.1%	61.1%	35.3%	27.9%	1.2%	58.1%	27.9%

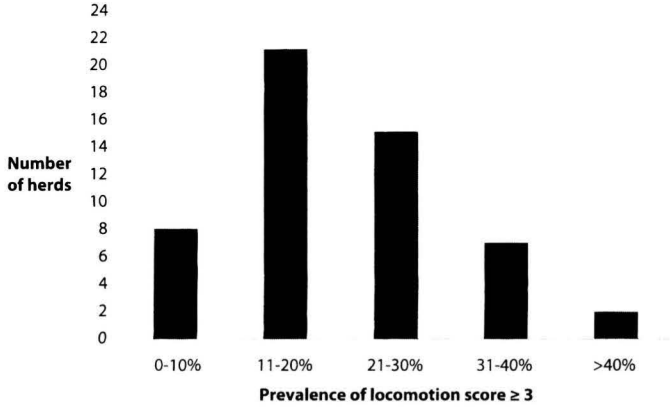

Figure 1. Number of herds in which the sample prevalence of lameness defined as locomotion score ≥ 3 was in the range of 0-10%, 10-20%, 20-30%, 30-40%, or > 40% (n = 53 herds).

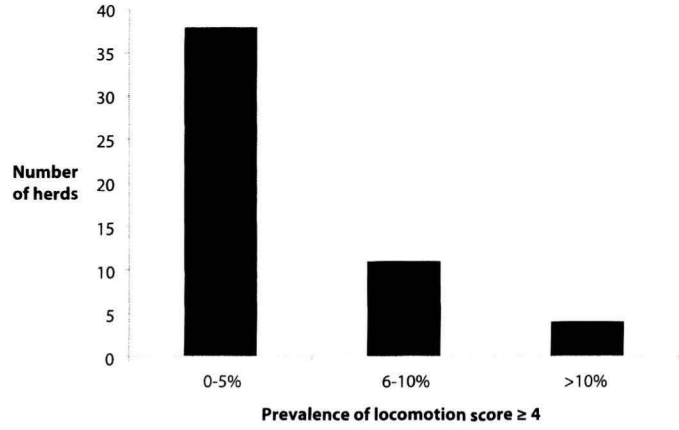

Figure 2. Number of herds in which the sample prevalence of lameness defined as locomotion score ≥ 4 was in the range of 0-5%, 5-10%, or > 10% (n = 53).

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Table 2. Comparison of mean prevalence of locomotion score ≥ 3 and locomotion score ≥ 4 by breed and by area. Holstein and Jersey refer to herds entirely of that breed. Cross refers to herds that have any combination of Holsteins, Jerseys, and Holstein-Jersey cross breeds. Area "east" includes herds located east of the Cascade mountain range while area "west" includes herds located west of the Cascade mountain range.

Mean prevalence	Breed			Area		Herd size	
	Holstein	Jersey	Cross	East	West	> 500	≤ 500
LS ≥ 3	22.5%[a]	11.4%[b]	21.9%[a]	17.0%[x]	23.3%[y]	20.5%	21.7%
LS ≥ 4	4.6%	4.1%	3.9%	1.6%[x]	5.9%[y]	3.2%[c]	5.7%[d]

[ab] Different ($P < 0.05$) from breed mean prevalence values in same row
[xy] Different ($P < 0.05$) from area mean prevalence value in same row
[cd] Trend for difference from herd size mean prevalence value in same row ($P = 0.06$)

et al.[7] Lameness prevalence described by Wells et al[16] was lower than in the present study.

When using multiple scorers in a prevalence study such as this, understanding how well their scores agree is important to assessing the accuracy of the prevalence estimate. For the 5-category locomotion score rating by the 8 observers, agreement beyond chance (κ = 0.41) could be classified as "fair" or "moderate",[17] and the rate of near agreement, within 1 locomotion score, was high. Given the high near agreement, weighted kappa would likely be greater than Randolph's kappa. However, Randolph's kappa was chosen for calculation so that multiple raters could be compared at once. For interobserver agreement between lame and sound cows at both definitions of lameness (LS ≥ 3 and LS ≥ 4), kappa (0.79 and 0.76, respectively) was considered "substantial agreement", with > 0.80 being classified as near-perfect agreement.[17] Therefore, herd prevalence estimates of both LS ≥ 3 and LS ≥ 4 would likely be consistent across observers.

There were many differences in methods between this and previous North American lameness prevalence studies. One difference was the sample selection process for determining which cows to assign a locomotion score. In the sampling strategy utilized in the current study, a sample of cows was selected from across pen groups, whereas in previous studies a group of high-production cows was selected[7,14] or all the cows on the farm were locomotion scored.[4,16] In the present study the population examined was different than that of studies of high-production groups, as cows were selected across all lactating cow groups. The sampling strategy utilized was previously evaluated and could predict whole-herd prevalence within plus or minus 5 percentage points.[11]

Locomotion scoring systems differed between this and previous studies. In the locomotion scoring system used in this study,[13] the minimum score classifying a lame cow (LS 3) is described as short-stride gait and arched-back walking and standing. Espejo et al[7] used the same criteria[13] with additional observations of tracking, head bob, and abduction/adduction suggested by another group.[12] In the study by von Keyserlingk et al,[14] another previously described locomotion scoring system[8] was utilized, where minimum criteria for the clinically lame cow included "arched back, steady head carriage, hind hooves do not track-up, joints show signs of stiffness, asymmetric gait, slight limp can be discerned." Cook[4] used a 4-point scoring system and defined lameness as 3 or 4 in which an LS 3 is described as "Often thin. Walks slowly, making deliberate short steps with an arched back, may favor a limb. Makes frequent stops. Encounters difficulty turning. Stands with an arched back and frequently lifts affected foot." In that scoring system a score of 2, which was not considered clinically lame, is described as short-stepping and walking with an arched back and standing with a flat back. In the present study, a cow observed to be short-stepping and walking with an arched back would be considered an LS 3, as observers were not required to observe the cow standing to distinguish LS 2 from LS 3. This difference could have resulted in an overestimate in this study compared to that of Cook,[4] although the prevalence results were similar. Wells et al[16] described a 5-point scoring system in which the minimum score considered clinically lame is described as "moderate and consistent gait asymmetry or symmetric gait abnormality, but able to walk without continuous stimulation." The differences between locomotion scoring criteria and minimum definition for lameness are highlighted here to suggest caution in direct comparison between studies. For future lameness research, a validated scoring system should be agreed upon among research groups to facilitate comparison between studies and over time.

Methodological differences aside, there were differences in the dairy herd demographics between studies. In the present study, cow housing in all herds was free-stall, open-lot, or a combination of both. In the studies of von Keyserlingk[14] and Espejo,[7] only free-stall

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housed herds were eligible for inclusion in the study. Cook[4] and Wells[16] examined herds with predominantly free-stall or tie-stall housing. Housing has an influence on lameness,[5] so predominant housing type may affect the lameness prevalence in different areas. The present study included Holstein, Jersey, and cross-breeds, all of which are currently common in the northwest. Previous studies have only included herds with Holstein[4,7,14] or predominantly Holstein[16] breed cows. Average herd size also varied between studies, likely reflective of regional herd demographics. In the studies of herds in Wisconsin and Minnesota, average herd sizes were 470,[7] 174.5,[4] 66.9,[4] and 50.2.[16] In the study by von Keyserlingk et al,[14] average herd sizes were 170 for British Columbia, 1,796 for California, and 826 for the northeast United States. In the present study, the average herd size of 1,040 was greater than all of the above areas except California. In the present study and most of the above-mentioned studies,[4,14,16] herds were not selected randomly so are not necessarily representative of their region demographically or for lameness prevalence.

Mean prevalence was different between breeds and areas. Herds with entirely Jersey breed cows had lower lameness prevalence than herds with entirely Holsteins and herds with both breeds and cross-breds. This finding at a herd level is consistent with previous studies in which Jersey breed cows had a lower prevalence of lameness than Holsteins.[1,2,11] There was a trend for large herds to have a lower mean prevalence of severe lameness. However, differences in mean prevalence between areas and between size groups were confounded by each other, and there were fewer small farms in eastern Washington than western Washington/Oregon. Large herds may have the ability to support more labor directed at hoof health, such as more frequent hoof-trimmer visits or employees trained for hoof treatment on the farm. In that way, it is possible that large herds have an increased treatment rate, and therefore decreased prevalence of severe lameness, because affected animals are identified and treated sooner. The present study was not designed to examine herd-size differences, thus further research would be needed to clarify the source of these effects. There was lower mean lameness prevalence in the east compared to the west. Possible reasons for lower lameness prevalence in the east area are drier climate, newer facilities, larger facilities, and increased prevalence of open-lot versus indoor housing.

Conclusion

Prevalence of lameness on 53 dairies in the northwestern United States was similar to or lower than prevalence previously reported in other areas, but caution should be used in comparing studies that use different sampling methods and locomotion scoring scales or criteria. Mean herd-level lameness prevalence was lower for farms in the eastern area of the region and lower for herds with entirely Jersey breed cows than herds with Holsteins or a combination of breeds. Estimating prevalence of lameness can serve as a starting point for evaluating individual farm progress in hoof health.

Endnotes

[a]Training Module: How to locomotion score dairy cows. Available at: http://extension.wsu.edu/vetextension/Lameness/Pages/Training.aspx. Accessed Jan 21, 2014.
[b]Excel, Microsoft Corp., Redmond, WA
[c]Epi Info (TM) Version 3.5.3, Centers for Disease Control and Prevention, Atlanta, GA

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