

Locomotion and hoof disease in cows in the first year of productive life in a slatted floor barn

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The aim of the research was to assess locomotion and the clinical health status of the limbs, with regard to production group and the stage and number of lactation, in dairy cows in the first year of operation of a free-stall barn with a slatted floor and an automatic milking system (AMS). Locomotion was evaluated in a herd of 115 cows after 6 months of operation of the cow barn. The number and stage of lactation were found to have a significant effect on leg health in the herd. Diseases of the horn of the hoof and skin of the toes were mainly observed in the hind legs.

KEY WORDS: slatted floor housing / locomotion / lameness / hoof disease

Lameness in dairy cows is currently one of the three main causes of economic losses. It reduces the animals' feed intake, productivity and welfare, and consequently leads to premature culling. Lameness refers to an abnormality in the way the cow walks, which is a clinical manifestation of numerous diseases and disorders. However, it should not be considered a disease or disorder itself, as a disease is a change in the structure or functioning of the body, while lameness is a consequence of these abnormalities [6, 11, 18].

Cows adopt a variety of abnormal postures to alleviate pain resulting from a diseased limb. Knowledge of these postures may help in the initial identification of the type and extent of a disease affecting the toes. The following abnormal postures are distinguished: sickle-hocked, camped out, bow-legged, abduction, adduction, knock knees of the hind limbs, and leg crossing. Other abnormal postures include a shortened stride, bending of the fetlock, keeping one side of the rump or one shoulder above the normal position,

keeping the head below the usual position or lifting the head when weight is placed on a diseased hind limb, and reluctance to put weight on a limb [4, 6].

A significant factor affecting both the hoof health and milk yield of cows is the type of material used for bedding in the stall. A softer and springier bedding surface prolongs the total time the animal lies on it and reduces the incidence of hoof disease [3, 5].

In 8 out of 10 cases, lameness involves diseases of the toes, and 85% of these cases affect the toes of the hind limbs. Half of hoof diseases involve the skin, mainly digital dermatitis, with 50% of the lesions occurring in the hoof horn, and as many as 70% of these in the outer horn. Failure to treat lameness and the diseases inducing it can lead to losses due to reduced milk production, weight loss, culling, infertility, and additional labour costs. According to various authors the occurrence of hoof diseases and their primary symptom, lameness, is 2% to 60% [9, 10, 13, 17].

The aim of the study was to evaluate locomotion and pathological lesions in the hoof horn in dairy cows during the first year of operation of a free-stall, slatted-floor barn equipped with an automatic milking system (AMS), taking into account the production group, stage of lactation and age of the cows.

Material and methods

The research was carried out in a dairy herd housed in a new barn stocked in June 2013. It is a free-stall building with a slatted concrete floor, furnished with rubber mats in the boxes and two milking robots. The slatted floor is cleaned every four hours by a robotic cleaner that pushes the waste into a tank under the building.

The locomotion of the cows was assessed using a modification of the 5-point scale described by Sprecher et al. [13]. It takes into account the cow's gait and the position of the back while standing and walking. Animals receiving a locomotion score of 1 are considered to be healthy. These cows show correct back posture both standing and walking, and their limbs are placed correctly. A score of 2 points characterizes a posture in which the gait is normal, but with abnormal back posture (subclinical lameness). A slight arch of the back is perceptible when the cow walks, but the back is normal when it is standing. Cows with a locomotion score of 3 or higher have a pronounced arch of the back both while standing and walking, and the degree of lameness is assessed on the basis of the cow's gait. Animals with moderate lameness, i.e. a locomotion score of 3 points, exhibit a shortened stride with at least one limb. Cows with a score of 4, classified as lame, favour the diseased limbs, while cows with a 5-point rating, indicating severe lameness, show extreme reluctance or even an inability to transfer weight onto the diseased limbs.

Locomotion was evaluated when the barn had been operating for 6 months and one week before hoof trimming was scheduled. During the evaluation, the herd consisted of

115 lactating cows of the Polish Holstein-Friesian breed (HO), 91 of which were primiparous. Two production groups were distinguished in the herd: I – cows from calving to about 200 days of lactation with production of over 25 kg of milk, and II – cows from over 200 days of lactation until the dry period. The analysis of the results also took into account a division into 3 groups according to the stage of lactation: I – up to 100 days, II – 101-200 days, and III – over 200 days.

The individual assessment of limb disease in the cows was performed during hoof trimming, distinguishing diseases of the hoof horn (e.g. ulcers) and of the toe skin (digital and interdigital dermatitis).

Statistical calculations were performed in SAS 9.3 [12]. Fisher's exact test was used for the statistical analysis because some subclasses of cows were small. This test was applied to contingency tables where one criterion was the health of the cows and the other (depending on the analysis) was the production group, age of the animals, or stage of lactation.

The incidence of hoof and toe skin diseases on each limb was analysed as well. Fisher's exact test was used to determine whether there were significant differences between the occurrence of lesions on the hind and front limbs. In this case, the criteria in the contingency tables were occurrence of the disease (yes or no) and the type of limb (front or rear). In addition, the test was used to determine whether there were correlations between the appearance of hoof and toe skin diseases on individual limbs, i.e. whether those diseases affected the same limbs.

Results and discussion

Varying degrees of lameness were noted in 28 cows in the herd, i.e. 25% (Table 1). In group I (cows with a yield of more than 25 kg and up to 200 days of lactation), symptoms of lameness were observed in 18% of animals and the mean locomotion score was 1.78. In Group II, nearly 30% of cows received a locomotion score of 3 or higher, and the average score was 2.15. Particular attention should be paid to cows with a locomotion score of 2. A substantial proportion of these cows, from 36% to 44% in our research, indicates the need for frequent monitoring of lameness in the herd and for the use of prophylaxis. This is especially important in the case of an automatic milking system, in which the cows decide when they will be milked. If walking causes them pain, they may delay milking and reduce its frequency. The statistical analysis, however, revealed no significant differences in the proportions of healthy (1 point), questionably lame (2 points), moderately lame (3 points), lame (4 points) and severely lame (5 points) animals among production groups. At the significance level $\alpha = 0.05$, Fisher's exact test, applied to the contingency table shown in Table 1, yields a p value of 0.1395.

Table 1
Results of evaluation of locomotion in cows according to production group

Production groups	N	Locomotion rating (score)										Average rating
		1		2		3		4		5		
		pcs.	%	pcs.	%	pcs.	%	pcs.	%	pcs.	%	
I	50	23	46.00	18	36.00	7	14.00	1	2.00	1	2.00	1.78
II	65	17	26.15	29	44.62	12	18.46	6	9.23	1	1.54	2.15
Total	115	40	–	47	–	19	–	7	–	2	–	1.99

Production groups: I – cows from calving to about day 200 of lactation with daily production above 25 kg; II – all other cows
Results of Fisher's exact test for groups of lameness
p-value: 0.1395

According to Greenough [6], if lameness affects more than 10% of cows in the herd, the problem requires a detailed analysis of its causes and the introduction of a prophylactic programme.

Locomotion was found to be worse in older cows than in primiparous cows (Table 2). The average score in this group was 2.5 points, and lameness was evident in as many as 50% of the animals. In the group of primiparous cows, symptoms of lameness were noted in 18% of the animals. The statistical calculations showed that these groups differed significantly in individual categories of limb health. Fisher's exact test showed a value of $p = 0.0176$. According to many authors [2, 7, 8, 16], age is a significant factor influencing the incidence of lameness. The older the cow, the more likely it is to become lame.

Table 2
Results of evaluation of locomotion in cows of different ages

Age	N	Locomotion rating (scores)										Average rating
		1		2		3		4		5		
		pcs.	%	pcs.	%	pcs.	%	pcs.	%	pcs.	%	
Primiparous	91	35	38.46	40	43.95	11	12.09	4	4.40	1	1.10	1.86
Multiparous	24	5	20.83	7	29.17	8	33.33	3	12.50	1	4.17	2.5

Results of Fisher's exact test for groups of lameness
p-value: 0.0176

In the mid-lactation period, 37% of cows exhibited disease symptoms (Table 3), but it should be noted that the problem occurred in a new cow barn with a high standard of equipment (milking robot, automatic feed pusher and robotic slat cleaner) and herd management (animal technician and management programme). Perhaps this can be explained by the fact that the cows introduced to the barn had been purchased and had previously been housed in barns that did not have a slatted floor.

According to Hirst [8], the highest risk of lameness occurs in the first few months after calving, while Bach et al. [1] suggest that most cases of lameness in cows are observed after peak production, i.e. between 4 and 8 months of lactation. Bielfeldt et al. [2] report that the highest risk of lameness occurs in cows in the second stage of lactation, and the lowest in the first stage. This is due to high production and high-energy feeding, which can lead to subclinical acidosis. At this time, nutrient deficiencies are revealed and the cows may become more susceptible to various diseases, including those of the skin and hoof horn.

In a study by Stefański et al. [14], half of diagnosed disease entities occurred in cows past the 200th day of lactation. This can be attributed to the fact that modern high-yield cows (with impaired immunity) have a high incidence of infectious diseases. The authors suggest a thorough study of pathogens causing this group of hoof diseases.

Table 3
Results of evaluation of locomotion in cows during different stages of lactation

Stage of lactation	Cows	N	Locomotion rating (scores)										Average rating
			1		2		3		4		5		
			pcs.	%	pcs.	%	pcs.	%	pcs.	%	pcs.	%	
I	total	24	12	50.00	7	29.17	5	20.83	0	0	0	0	1.71
	primiparous	21	11	52.38	7	33.33	3	14.29	0	0	0	0	1.62
II	total	46	14	30.43	15	32.61	11	23.91	4	8.70	2	4.35	2.24
	primiparous	30	10	33.33	12	40.00	5	16.67	1	3.33	2	6.67	2.10
III	total	45	14	31.11	25	55.56	3	6.67	3	6.67	0	0	1.89
	primiparous	40	14	35.00	21	52.5	3	7.50	2	5.00	0	0	1.83

Stage of lactation: I – up to 100 days, II – 101-200 days, III – over 200 days
Fisher's exact test results for groups of lameness
p-value: 0.0444

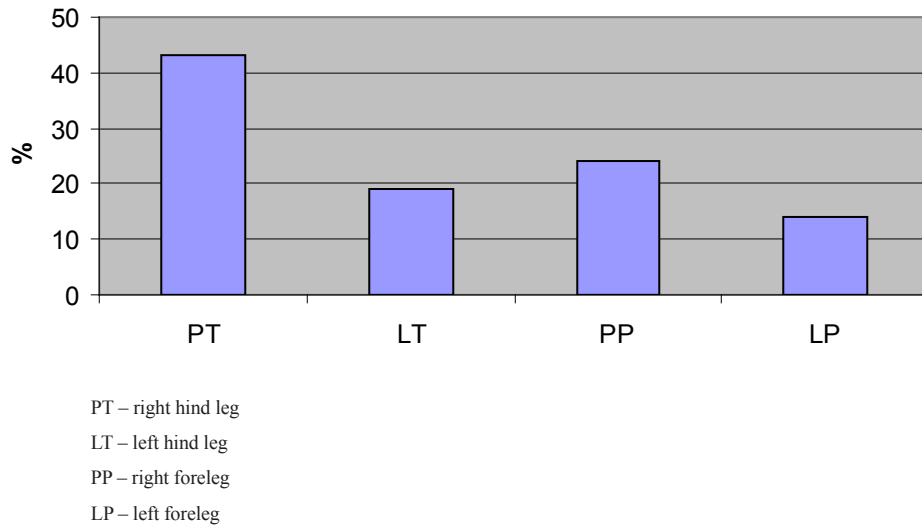


Fig. 1. Distribution of hoof horn disease in each limb in the herd of cows

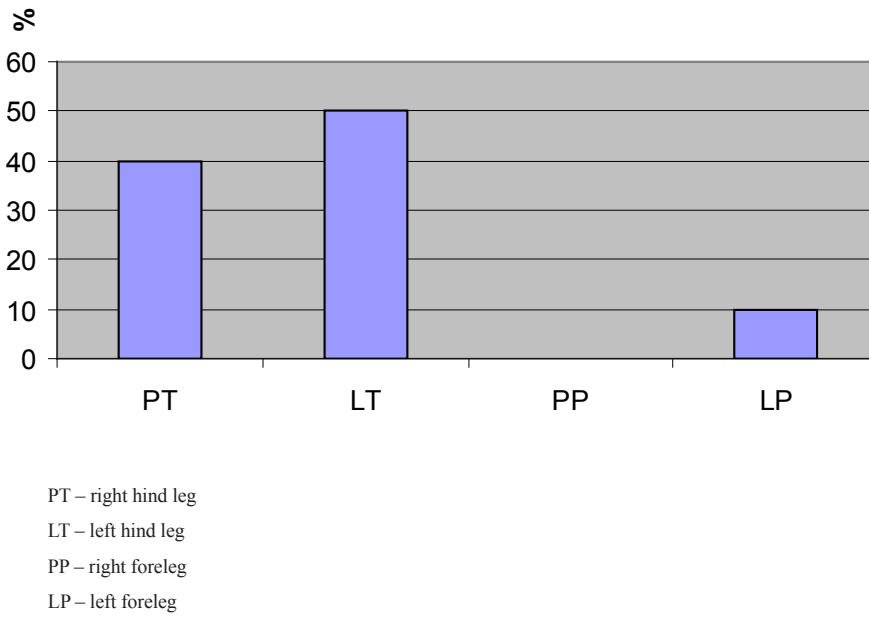


Fig. 2. Distribution of skin disease in the toes of each limb in the herd of cows

According to Bielfeldt et al. [2], high yield is conducive to lameness. The risk of lameness is nearly twice as high in cows with yield of over 7,000 kg of milk as in those whose yield is less than 6,000 kg of milk.

The differences in the assessment of the locomotion of cows in different stages of lactation were confirmed statistically. Fisher's exact test showed $p = 0.0444$. To determine more precisely between which groups the differences occurred, an ad-hoc procedure was carried out to compare all lactating groups in pairs. Significant differences were found between groups I and III ($p = 0.0403$), i.e. cows in the first stage of lactation (0-100 days) and in the third (over 200 days), and between groups II and III ($p = 0.0486$), i.e. cows in the second stage of lactation (101-200 days) and the third (over 200 days). Although the mean locomotion score was most favourable in cows in the first stage of lactation (1.71 points), the difference with respect to group II (2nd stage of lactation), which had the worst score, was statistically insignificant ($p = 0.3911$), probably due to the relatively small number of animals in group I. The results of the assessment confirm that the primiparous cows exhibited better locomotion in each stage of lactation (Table 3).

The data presented in Figures 1 and 2 show that it is primarily the hind limbs that are susceptible to diseases of the hoof horn. Disease symptoms of the hind limbs were found to account for 62% of all cases, but Fisher's exact test showed no significant differences in the incidence of this condition between the front and rear limbs, $p = 0.2167$. Toe skin diseases mainly affected the interdigital space and were noted mainly in the hind limbs – 90% of all cases. In this case the differences are significant, $p < 0.0001$. Fisher's exact test also showed no statistically significant differences in the prevalence of symptoms of hoof diseases and skin diseases on individual legs ($p = 0.11947$), which means that these conditions mainly affect the same limbs.

According to Greenough [6] and Telezhenko and Bergsten [15], the problem of hind leg damage is linked to the type of floor on which the animals are housed. The worst conditions are found in slatted-floor barns, which have the lowest coefficient of friction of all floor types, making them slippery and uncomfortable for the animals. Cows are reluctant to walk on them and shorten their stride significantly, due to the increased point load on the sole. Poorly constructed floors, i.e. with gaps larger than 2.5 cm or unevenly placed slats, cause numerous injuries within the tip of the hoof.

In conclusion, the age of the cows analysed and their stage of lactation were factors which had a significant effect on the health of their limbs, while in the case of the production group, no such influence was observed.

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