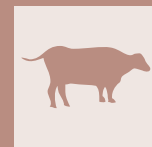


Frequency of White line disease and Sole ulcers and impact of hoof trimming in examined herds of Simmental cows



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SUMMARY

Lameness as a consequence of hoof disorders is gaining significance in animal health considerations with a particular impact in tie-hold systems. Preventive hoof trimming becomes an important zotechnic measure and procedure for the health and welfare improvement of cows. The objective of our study was to demonstrate findings of sole ulcers and white line diseases of cattle on smallholder farms. Another aspect was to display our observations on hoof trimming within the perspective of sole ulcers and white line disease in the examined herds. A total of 108 Simmental cows from 14 small noncommercial farms located in the Mačva district, Western Serbia, from March to October in 2020 were observed. The trimming procedure was performed by the Dutch method with cows fixed in a mobile chute for hoof trimming. Also, medical treatment of the hoof was provided as needed, using orthopedic foot blocks (wooden and rubberized blocks). Before treatment the white line disease and sole ulcers were present in 12 herds (85.7%). After treatment, there was a decrease in the frequency of sole ulcers positive herds (from 85.7% to 78.5%), while the frequency of white line disease in herds remained unchanged. Regarding cows, a frequency of white line disease of 25.0% was reduced to 18.5%, showing a significant difference ($p < 0.05$) before and after treatment. The frequency of sole ulcers in cows of 23.1% was reduced to 15.7% on re-examination six months after trimming though the difference was not significant, respectively ($P < 0.05$). White line disease and sole ulcers are widespread diseases of hooves on small noncommercial farms in Serbia. This study also provides insights that show the health status of cows' hooves and demonstrated the importance of regular hoof trimming. Our findings suggest that regular hoof trimming (twice a year) and adequate housing conditions are crucial for improving the health of hooves.

KEY WORDS

Hoof trimming; Lameness; Simmental cows; Sole ulcers; White line disease.

INTRODUCTION

Lameness of dairy cows is one of the most common reasons for their exclusion from production¹. Factors that lead to lameness are constant holding in deep litter straw beds, insufficient wear of the horn, irregular trimming of the hooves, poor horn quality, mechanical lesions, and wet conditions in stalls as well as the breed and nutrition². The most usual noninfective lesions which occur in dairy cattle are sole ulcers and white line disease³, which together lead to the greatest economic losses among all foot diseases in dairy cattle⁴. They directly decrease the milk yield, lead to weight loss^{5,6} and affect the occurrence of reproductive disorders⁷. High milk yield, age, and body condition of cows can all be risk factors for the development of white line disease and sole ulcers of cows⁸. In Hungary economic losses due to lameness were € 61.60 per cow or € 320.10 per case⁹. The main cause of white line disease and sole ulcers is laminitis¹⁰. The sole ulcer is specific lesions of the sole, and has a multifactorial etiology¹¹. As a consequence of laminitis, there are circulatory changes resulting from rotation of the phalangeal bone, these statistical-mechanical changes lead to pressure on the corium of the soles and development of haemorrhagic-necrotic changes and

predisposition to the appearance of sole ulcers^{12,13}. Vascular changes at the site ulcer include edema, hemorrhages, necrosis and an increased number of arterio-venous anastomoses¹⁴. The pathological process in sole ulcers is the most prevalently located on the hind legs, on the outer claw of the hoof because it carries more weight than the inner claw¹⁵. Neglecting of hoof trimming procedure leads to horn overgrowth followed by the increased incidence of sole ulcers¹⁶. The risk of developing sole ulcers is higher if cows stand longer on a solid surface¹¹. White line disease involves hemorrhage, fissure, and abscess between the sole and the wall of the hoof and is predominantly localized to the outer claw of the hind hoof^{17,18}. Laminitis, which disrupts blood flow to the corium, leads to poor production and quality of keratinocytes that result in cracks in between keratinocytes along the white line and the development of white line disease¹⁰. Due to changes along the white line, a separation wall occurs between the hoof wall and the sole of hoof⁸. Loss of continuity between the sole and the wall of the hoof allows the colonization of pathogenic bacteria aided by environmental factors moisture and dirty surroundings, and penetration to the corium can result in the appearance of lameness¹⁹.

Cows with lameness are 25% less likely to remain pregnant, which is in line with the fact that the highest prevalence of sole ulcers is around the peak of lactation⁸. Studies have shown that the impact of sole ulcers and white lines can lead to a reduction of milk production by 574 kg and 369 kg per lactation, respectively²⁰.

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Cows affected with white line disease and sole ulcers in the first third of lactation had milk production reduced by 324 kg compared with later lactation stages²¹. Hoof trimming aims to improve the balance of the foot, provide relief from the overgrown horn, improve the health of hooves, and to prevent the onset of hoof diseases, and usage of therapeutics^{22,23}. We have estimated the frequencies of white line disease and sole ulcers on small farms in Serbia because of the lack of detailed data on the frequencies of these diseases in Serbia. The subject is also of particular interest due to the choice of breed of cows, and their housing. Thus, the aim of this report is to deliver the first information on white line and sole ulcers in smallholders' farms in the Ma va district in the Republic of Serbia and to study the effect of hoof treatment on the frequency of hoof diseases.

MATERIAL AND METHODS

Study population

This study was conducted on a total of 108 Simmental dairy cows from 14 smallholders' farms located in four municipalities (Vladimirci, Koceljeva, Šabac, and Loznica) in the Ma va district, Western Serbia. Ages of cows were from 3 to 9 years. All cows enrolled in this study were kept in tie-stall farms, from the first to seventh lactation with an average yearly milk yield of 5700 kg. The diet, although not uniform in all farms, was based on corn silage, alfalfa hay, and concentrate with about 16% protein in the meal. All herds had a concrete stall base with deep litter straw beds. The study took place from March to October 2020. All cows had their hooves trimmed between 60 and 180 days of lactation.

Data collected

Information regarding milk yield and feeding was obtained by interview with farm owners. The clinical examination focused on all possible visible alterations on the hooves. Changes were

exclusively found on hind feet, with no alterations exhibited on front feet hooves. The history of previous hoof trimming was not disclosed by all farmers. The trimming procedure was performed using the Dutch method, with cows fixed in a mobile chute for hoof trimming. In addition, medical treatment of the hoof was provided as needed, using orthopedic foot blocks (wooden and rubberized block).

Statistical analysis

Descriptive statistics were prepared using the office software package (Microsoft® Excel® MSO, 2016), while the significance of differences before and after treatment was tested using a paired-sample t-test in GraphPad® Prism®6 software. Farms with fewer than 7 cows were excluded from the statistical comparison of the observed groups. P-values ≤ 0.05 were considered significant.

Statement of ethical compliance

The experiment was done in compliance with Serbian Law on Animal Welfare (Official Gazette of the Republic of Serbia No 41/09) and Ordinance on the conditions for registration for experimental animals and the keeping of such a register, training programs on welfare on experimental animals, request forms for approval of conducting experiments on animals, standing, treatment and killing experimental animals and reproduction, circulation, or implementation experiments on animals (Official Gazette of the Republic of Serbia No 39/10).

RESULTS

The average size of the herds in this study was 7.71 with standard deviation of 4.18 cows. In this study, both lesions concomitantly, white line disease and sole ulcers, were present in 10 of 14 herds (71.43%). Data of the frequency of white line disease and sole ulcers on smallholders' farms are presented in Table 1.

Table 1 - Occurrence of sole ulcer and white line diseases in cows on smallholders' farms.

	Number of cows in herd	Before treatment		After treatment	
		White line disease	Sole ulcers	White line disease	Sole ulcers
1	15	4	2	4	0
2	3	0	1	0	1
3	8	2	2	1	2
4	12	3	3	1	2
5	8	0	2	1	2
6	3	1	0	1	0
7	6	1	2	2	0
8	14	3	3	2	1
9	11	2	5	1	4
10	1	1	1	0	1
11	7	3	0	2	1
12	6	2	1	1	1
13	5	3	1	3	1
14	9	2	2	1	1
Total	108	27	25	20	17
	Frequency %	25	23.1	18.5	15.7

White line disease

Before treatment the frequency of white line disease was present in 12 out of 14 herds (85.71%). Amongst the 108 examined cows, the frequency of white line disease was 27 (25.0%). After treatment, the frequency of herds with white line disease remained unchanged, but the frequency of white line disease on the 108 cows was reduced to 20 (18.5%); a significant difference in the occurrence of white line disease in cows before and after hoof trimming of $P < 0.05$ ($P = 0.0479$).

Sole ulcer

Prior to treatment, sole ulcer frequency was essentially the same as the white line disease i.e. present in 12 of the 14 herds (85.71%), and found in 25 (23.1%) cows. Subsequent to treatment, the number of herds affected dropped to 11 (78.6%), and the number of findings dropped to 17 (15.7%) cows. Decrease of sole ulcers showed no significant difference before and after treatment ($P > 0.05$, $P = 0.0796$).

DISCUSSION

Regular hoof trimming enables insight into the health condition of the hoof and detection of subclinical claw lesions before the appearance of visible lameness. The importance of determining the frequency of hoof disorders in the herd is considerable, because farmers notice when cows become lame. White line disease and sole ulcers are the most common claw lesions in dairy cows¹². On the territory of Serbia, previous authors have estimated the frequency of white line disease and sole ulcers in cows to be 6.18% and 3.35% on mini-farms in mountainous Serbian areas²⁴. Contrary to this, Bojkovski et al.¹³ estimated the frequency of sole ulcers 21.83% cows on seven farms with tie stall housing. The variable frequencies of white line disease and sole ulcer may be due to the fact that some cows develop pathological lesions without observable lameness²⁵. The prevalences of white line disease and sole ulcers were 12.1% and 9.4%, respectively, in free stalls with deep straw bedding in Slovakia²⁶. Four main risk factors may have caused the findings in our study: irregular hoof trimming, non-adequate conditions, wet, dirty surroundings, the negative effects of concrete flooring with deep litter straw beds, so the probabilities for the occurrence of white line disease and sole ulcers were high in the presence of these predisposing factors²⁷. Body condition score (BCS) and digital cushion thickness are factors that may affect our results. Cows with BCS < 3.5 have higher probabilities of foot disease, and composition digital cushion, therefore ratio of connective and adipose tissue have plays in the onset of hoof disease²⁸. Due to insufficient walking surfaces on the farms, the tied way of keeping the cows does not lead to even wear of the horn and is itself an introduction to the appearance of hoof disorders. However, a significant factor influencing the overall health of cows is hoof trimming²⁹, which had a positive impact, leading to a decrease in the frequency of white line disease and sole ulcers in our study.

A prevalence of white line disease of 8.8% was found in Sweden¹². Sole ulcers were reported in 85% of herds in the Netherlands with a 1-5% prevalence among cows¹¹. A factor that may have affected the results in our study was the lack of previous or irregular trimming practice of cows amongst the farms we studied.

Using deep litter straw beds for beddings was found to reduce the prevalence of white line disease and sole ulcers³⁰, and our general observation supports these findings for decreased frequencies of white line disease and sole ulcers. On the other hand, there are reports that hoof trimming may not lead to reduced prevalence of sole ulcers³¹ and our findings haven't shown a statistically significant reduction of sole ulcer frequency on the observed farms ($P > 0.05$). The appearance of white line disease and sole ulcers in Simmental cows has been rarely investigated concerning lameness.

CONCLUSION

White line disease and sole ulcers are widespread diseases of hooves on small noncommercial farms in Serbia. This study also provided insights into the health status of cows' hooves and demonstrated the importance of regular hoof trimming. Regular hoof trimming twice a year with adequate ambient conditions can maintain the good health of hooves.

Competing interests

The authors declare that they have no conflict of interest.

Aknowledgements

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References

- Dippel S., Dolezal M., Brenninkmeyer C., Brinkmann J., March S., Knierim U., Winckler C. (2009). Risk factors for lameness in cubicle housed Austrian Simmental dairy cows. *Prev Vet Med.* 90 (1-2): 102-112.
- Bell N.J., Bell M.J., Knowles T.G., Whay H.R., Main D.J., Webster D.J. (2009). The development, implementation and testing of a lameness control programme based on HACCP principles and designed for heifers on dairy farms. *Vet J*, 180 (2): 178-188.
- International Lameness Committee. (2008) Dairy claw lesion identification. In: Proceedings 15th International Symposium of the 7th Conference Lameness in Ruminants, Kuopio, Finland. Savonia University of Applied Sciences, Kuopio, Finland.
- Bruijnjs M.R.N., Beerda B., Hogeveen H., Stasen E.N. (2012). Assessing the welfare impact of foot disorders in dairy cattle by a modeling approach. *Animal.* 6 (6): 962-970.
- Reader J.D., Green M.J., Kaler J.S., Mason S.A., Green L.E. (2011). Effect of mobility score on milk yield and activity in dairy cattle. *J Dairy Sci*, 2011; 94 (10): 5045-5052.
- Bojkovski J., Hadžić I., Rogožarski D., Pavlović I., Savić B., Đedović S. (2013). Contribution to knowledge laminitis by dairy cows in Serbia, *Lucrări Stiintifice: Medicina Veterinara Timisoara*, 46 (4): 24-32.
- Walker S.L., Smith R.F., Jones D.N., Routly J.E., Morris M.J., Dobson H. (2010). The effect of a chronic stressor, lameness, on detailed sexual behaviour and hormonal profiles in milk and plasma of dairy cattle, *Reprod Domest Anim*, 45 (1) 109-117.
- Bicalho R.C., Machado V.S., Caixeta L.S. (2009). Lameness in dairy cattle: A debilitating disease or a disease of debilitated cattle? A cross-sectional study of lameness prevalence and thickness of the digital cushion. *J Dairy Sci*, 92 (7): 3175-3184.
- Ózsvári L., Barna R., Visnyei L. (2007). Economic losses due to bovine foot diseases in large-scale Holstein-friesian dairy herds (in Hungarian). *Magy Állatorv Lapja*, 129 (1): 23-28.
- Mulling C. (2002). Theories on the pathogenesis of white line disease-an anatomical perspective. In: Proceedings of the 12th International Symposium on Lameness in Ruminants, Orlando, FL, USA. pp. 90-98.
- Holzhauser M., Hardenberg C., Bartels C.J. (2008). Herd and cow-level prevalence of sole ulcers in The Netherlands and associated-risk factors. *Prev Vet Med.* 85(1-2): 125-135.

12. Manske T., Hultgren J., Bergsten C. (2002). Prevalence and interrelationships of hoof lesions and lameness in Swedish dairy cows. *Prev Vet Med*, 54 (3):247-263.
13. Bojkovski J, Hadžić I, Prodanović R, VujanacI, Nedić S., Arsić S., Pavlović I., Zdravković N., Bojkovski D., Becskei Z., Dobrosavljević I., Milanov D., Relić R. (2019). Prevalence of claw disorders in dairy farms with tie stall. *Lucrări științifice medicină veterinară Timișoara*, 2 (1): 10-16.
14. Van Amstel S.R., Shearer J.K. (2006). Review of Pododermatitis circumscripta (ulceration of the sole) in dairy cows. *J Vet Intern Med*, 20(4):805-11.
15. Fiore E., Perillo L., Marchesini G., Piccione G., Giudice E., Zumbo A., Armato L., Fabbri G., Giancesella M. (2019). Effect of parity on claw horn lesions in Holstein dairy cows: clinical and radiological study. *Ann Anim Sci*, 19 (1): 147-158.
16. Atkinson O. (2013). Practical and effective management of foot lameness in dairy herds. *Practice*, 35 (4): 171-82.
17. Greenough P.R. (2007). *Bovine Laminitis and Lameness*. 1st Edn., Elsevier Science Health Science Division.
18. Nouri M., Nowrouzian I, Marjanmehr SH, Vajhi A, Faskhousi D. (2013). Pathomorphological findings of white line disease with digital and inner organ infections in culling dairy cows. *Am J Anim Vet Sci*, 8 (3): 122-127.
19. Shearer J.K., Plummer P.J., Schleining J. (2015) Perspectives on the treatment of claw lesions in cattle. *Vet Med (Auckl)*, 6: 273-292.
20. Amory J.R., Barker Z.E., Wright J.L., Mason S.A., Blowey R.W., Green L.W. (2008). Associations between sole ulcer, white line disease and digital dermatitis and the milk yield of 1824 dairy cows on 30 dairy cow farms in England and Wales from February 2003-November 2004. *Prev Vet Med*, 83 (3-4): 381-391.
21. Zlatanović Z., Hristov S., Stanković B., Cincović M., Nakov D., Bojkovski J. (2021). Influence of claw disorders on milk production in Simmental dairy cows. *Kafkas Unive Vet Fak Derg*, 27 (1): 103-110.
22. Bryan M., Tacoma H., Hoekstra F. (2012). The effect of hind claw height differential and subsequent trimming on lameness in large dairy cattle herds in Canterbury, New Zealand. *N Z Vet J*, 60 (6): 349-355.
23. Canatan U., Hasan K., Akbala M., Cetin M., Acar H., Aslan V., Altinci Saril C., Mekik Temiz E., Yigitgor P., Salci H. (2021). How effective is individual claw trimming in cattle? An ex-vivo study. *Large Anim. Rev*, 27: 9-14.
24. Milosavljević P., Savić-Stevanović V. (2013). Frequency of some acropodium diseases in dairy cows in Serbia. *Acta Vet-Belgrade*, 63 (2-3): 247-254.
25. Solano L., Barkema H.W., Mason S., Pajor E.A., LeBlanc S.J., Orsel K. (2016). Prevalence and distribution of foot lesions in dairy cattle in Alberta, Canada. *Journal of Dairy Science* 2016; 99 (8): 6828-6841.
26. Mudroň P. (2016). Effects of manure bedding on the rate of claw diseases in dairy cows. *Folia Vet*, 60 (4): 14-19.
27. Barker Z.E., Amory J.R., Wright J.L., Blowey R.W., Green L.E. (2007). Management factors associated with impaired locomotion in dairy cows in England and Wales. *J Dairy Sci*, 90 (7): 3270-3277.
28. Fabbri G, Giancesella M, Morgante M, Armato L, Bonato O, Fiore E. (2020). Ultrasonographic alterations of bovine claws sole soft tissues associated with claw horn disruption lesions, body condition score and locomotion score in Holstein dairy cows. *Res in Vet Sci*, 131: 146-152
29. Gudaj R, Brydle E, and Lehoczyk J. (2013). Different management methods on prevalence of lameness in 25 holstein-friesian herds in Hungary. *Acta Vet-Belgrade*, 63 (4): 405-420.
30. Livesey C., Harrington T., Johnston A., May S., Metcalf J. (1998) The effect of diet and housing on the development of sole haemorrhages white line haemorrhages and heel erosions in Holstein heifers. *Anim Sci*, 67(1): 9-16.
31. Van der Tol P.P.J., Van der Beek S.S., Metz J.H.M., Noordhuizen-Stassen E.N., Back W., Weijs W.A. (2004). The effect of preventive trimming on weight bearing and force balance on the claws of dairy cattle. *J Dairy Sci*, 87 (6): 1732-1738.