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REGULAR ARTICLES

Frequency and distribution of foot lesions identified during cattle hoof trimming in the Province of Antioquia, Colombia (2011–2016)

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Abstract

Lameness is a severe welfare problem in cattle and has a detrimental effect on longevity, productivity, and reproductive performance. This study aimed to describe the frequency and distribution of foot lesions in cattle using hoof trimming records over a period of 6 years in the Province of Antioquia (Colombia). The data collection instrument enabled differentiation between limbs, digits, and views. The Claw Lesion Identification in Dairy Cattle brochure was the reference for foot lesion identification. A total of 1814 foot lesions observations, recorded from 1120 cows in 71 herds, were analyzed and 11 different foot lesions were identified. Non-infectious foot lesions were more common than infectious (94.4 vs 5.6%). White line disease was more frequently observed in the hind limbs (79.6%) compared to the front limbs (20.4%), and more frequent in medial claws of the front limbs (70.3%) compared to lateral claws (29.7%). In hind limbs, the lateral claws were more commonly affected (65.7%) compared to the medial claws (34.3%). Claw zone 3 was affected in 61.3% of the cases, followed by zones 2 (21.7%) and 1 (17%). Although our data are from a limited area of the country, they are consistent with published and anecdotal reports of foot lesions in cattle in Colombia and worldwide. Our results suggest that there is need for additional prospective research under Colombian dairy cattle management conditions to better understand the lameness and benefit of trimming intervention.

Keywords Bovine claw · Claw trimming · Foot diseases · Lameness · Preventive health

Introduction

Lameness in cattle has been associated with a negative effect on longevity, productivity, and reproductive performance (Oltenacu and Algers 2005; Cramer et al. 2009), leading to economic losses (Green et al. 2002; Ettema and Ostergaard 2006; Amory et al. 2008; Bruijnis et al. 2010; Green et al. 2010; Charfeddine and Perez-Cabal 2017). Moreover, lameness constitutes an animal welfare concern, since lameness causes substantial reduction in the nociceptive threshold which can persist even after apparently effective treatment of the cause of lameness (Whay et al. 2005). Thus, lame cows are chronically hypersensitized to other sources of pain, as well as having chronic pain associated with the lesion (Chesterton et al. 2008; Bruijnis et al. 2012a, b).

Over 90% of lameness in dairy cattle involves the foot (Shearer 2006; Cramer et al. 2008; Holzhauer et al. 2008; Becker et al. 2014; Solano et al. 2016). According to their etiology, foot lesions are categorized into infectious and non-infectious (International Lameness Committee 2008; Potterton et al. 2012). Infectious foot lesions include

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digital dermatitis, interdigital dermatitis, heel erosion, and foot rot. These lesions usually affect the foot skin and are exacerbated by herd-level factors (e.g., wet and unhygienic floor conditions, foot-bathing frequency) (Somers et al. 2005a, b; Bell et al. 2009; Cramer et al. 2009). Non-infectious foot lesions include white line disease (WLD), sole ulcer, sole hemorrhage, toe ulcer, corkscrew claw, horizontal fissure, vertical fissure, axial fissure, interdigital hyperplasia, and thin sole. White line disease, sole ulcer, sole hemorrhage, and possibly toe ulcer are associated with metabolic or hormonal events around parturition that weaken the suspensory apparatus of the third phalanx (Manske et al. 2002; Tarlton et al. 2002; Somers et al. 2003; Bicalho et al. 2009; Green et al. 2014).

Prevalence of foot lesions varies considerably among farms, regions, and housing systems (Solano et al. 2016). Reports on foot lesions in tie-stall systems were lower than in free-stalls (48 vs 71.8%) (Sogstad et al. 2012). Cow-level prevalence of digital dermatitis ranged from 8% in Chile to 23% in Ontario (Cramer et al. 2008; Tadich et al. 2010). Herd-level prevalence of digital dermatitis ranged from 69.7 to 96.7% when cows are housed on concrete flooring, compared with cows housed in deep-bedded straw yards (Somers et al. 2003; Cramer et al. 2008). Solano et al. (2016) reported that overall foot lesion prevalence was higher on farms with partial-herd compared to whole-herd trimming (37.9 vs 26.8%).

Although prevalence of lameness has been widely reported in other countries, there are few reports in Colombian cattle. The objective of this study was to describe the frequency and distribution of foot lesions using observations recorded by a cattle hoof trimmer during a 6-year period in the Province of Antioquia (Colombia).

Materials and methods

Description of the study area

The herds included in this study were distributed among four of the nine regions of the Province of Antioquia. Antioquia is one of the 32 provinces of Colombia, having 11.6% of the cattle population of the country (ICA 2016). The geographical region of Antioquia consists of a large mountainous area with elevations ranging between 1000 and 4080 m.a.s.l. (Gobernación de Antioquia 2016). According to weather data, and due to tropical and isothermal tendencies in the country, months were grouped into dry or rainy (wet months). January, February, June, July, August, and December are considered the dry months (with sporadic rains—1910 mm/year, sunny days, and high humidity). March, April, May, September, October, and November are considered rainy months (with intermittent rains—4672 mm/year and lower temperatures) (Gobernación de Antioquia 2016).

Study population and data collection

The data used in this study included all available records collected between March 2011 and December 2016 during routine hoof trimming visits performed by one experienced hoof trimmer. The data collected included general information (date of the visit, municipality, farm ID, cow ID) as well as foot lesion-specific information (definition and location by limb, feet, and claw). The Claw Lesion Identification in Dairy Cattle brochure, co-developed by Zinpro® Corporation (D40-08-30-07 03/2012, Eden Prairie, MN) and The International Lameness Committee (2008), was consider as the reference for foot lesion identification. This poster uses color photos of 14 lesions along with 12 claw/foot zones affected by each type of lesion. Findings were reported only if a lesion was found during trimming procedures and therefore recorded by the hoof trimmer.

Data management and analysis

Data was manually recorded by the hoof trimmer and entered into Excel worksheets (Microsoft Corp., Redmond, WA, USA) by two of the authors (NC and IC). Descriptive statistics and significant differences ($p < 0.05$) were assessed using a chi-square test and then presented as percentages and 95% confidence intervals (CIs) based on the total number of foot lesions recorded in the dataset. Statistical analyses were done using Stata 14.0 (StataCorp 2015, Texas, USA).

Results

A total of 1588 foot lesions observations were recorded on 1120 animals from 71 herds located in 14 municipalities (primary political division of provinces). Overall, 66 incomplete records (3.6%) were identified. Therefore, the number of cases may differ for each result section. Table 1 shows the frequency of foot lesions by year and month of report. Figure 1 shows over monthly distribution of the specific lesions across the years.

No difference was observed between the percent of foot lesions reported during rainy months (49.2%; 782/1588) and dry months (50.8%; 806/1588). Most of the foot lesions reported corresponded to visits conducted in the Northern region (65.3%; 1037/1588), followed by the Eastern (23.1%; 367/1588), Metropolitan area of Medellin (10.6%; 168/1588), and in the Western region (1%; 16/1588). Data were predominantly collected from dairy farms (97.2%; 1543/1588), compared to dual purpose

Table 1 Foot lesion observations reported by year in cattle examined during routine foot trimming in the Province of Antioquia (Colombia), 2011–2016

Year	Observation	Distribution (%)
2011	142	7.8
2012	205	11.3
2013	157	8.7
2014	160	8.8
2015	561	30.9
2016	589	32.5
Total	1814	100

(2.5%; 40/1588) and beef farms (0.3%; 5/1588). Foot lesions were most frequently reported in cows (98.9%; 1570/1588) compared to bulls (1.1%; 18/1588).

Frequency of foot lesions

Eleven different foot lesions were identified and recorded. Non-infectious lesions were the most commonly diagnosed (94.4%). Infectious foot lesions reported were digital and interdigital dermatitis (5.6%). The most frequent foot lesion was WLD, followed by sole ulcer and toe ulcer. Data on distribution and frequencies of foot lesions by limb, foot, and by claw are presented in Table 2. Claw zones affected by each of the foot lesions reported in this study are shown in Fig. 2.

Discussion

This study provides baseline data on the distribution of foot lesions (within feet, limb, and claw zone) in selected regions of Colombia. Data were collected from commercial cattle farms during regular foot trimming. Because these observations were collected in one of the most representative Colombian dairy regions (Gobernación de Antioquia 2016), we believe our results offer insight on the most frequent causes for foot care and trimming consultation in our conditions. Furthermore, results of the present study may be used to develop on-farm preventive measures, establish the guidelines for future research, and incorporated into educational programs for veterinarians and producers.

According to our database, non-infectious foot lesions were more frequently reported than infectious. This can be due to environmental conditions related to pasture-based systems, commonly observed in the regions of study. Risk factors may differ from those reported in the literature in countries that have more distinctive seasonal weather patterns, mainly based on confinement-based systems (Passos et al. 2017). Even considering that digital and interdigital dermatitis (defined as infectious foot lesions) were not a frequent finding in this study, special attention should be paid to the implementation of preventive measures for their control, to assure their incidence does not increase.

Our findings support a framework of knowledge about the role of anatomy and weight-bearing dynamics in the pathogenesis of foot lesions. Most of the foot lesions reported herein were on the hind lateral claws as reported previously (Sagues 2002; van der Tol et al. 2003; Shearer et al. 2005; Shearer 2006; Greenough 2007; Blowey and Weaver 2011). White line disease was by far the most common foot lesion observed in this study, followed by sole and toe ulcer. Consistent with the literature, WLD more frequently affected the abaxial

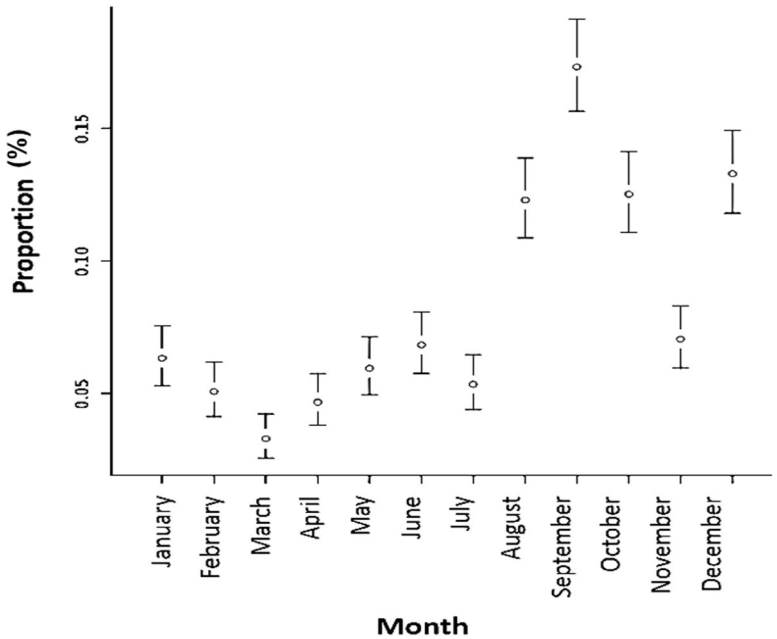

Fig. 1 Foot lesions observations reported by month in cattle examined during routine foot trimming in the Province of Antioquia (Colombia), 2011–2016

Table 2 Distribution and frequency of foot lesions by limb, foot, and by claw of cattle from the Province of Antioquia (Colombia), 2011–2016

		N of lesions (%) [95 %CI][†]										
		White line disease	Sole ulcer	Toe ulcer	Digital dermatitis	Interdigital hyperplasia	Sole hemorrhage	Axial fissure	Interdigital dermatitis	Horizontal fissure	Corkscrew claw	Vertical fissure
Front limbs	Medial	109 (70.3) [63.1–77.5]	46 (63.9) [52.8–75.0]	27 (51.9)	–	–	3 (50)	6 (100)[a]	–	8 (61.5)	0 (0)	0 (0)
	Interdigital	–	–	–	10	8	–	–	4	–	–	–
	Lateral	46 (29.7) [22.5–36.9]	26 (36.1) [25.0–47.2]	25 (48.1)	–	–	3 (50)	0 (0)	–	5 (38.5)	1 (100)[a]	2 (100)[a]
	Total	155 (20.4) [17.6–23.3]	72 (18.6) [14.7–22.5]	52 (27.4) [21.0–33.7]	10 (14.1) [6.0–22.2]	8 (14.3) [5.1–23.4]	6 (18.2) [5.0–31.3]	6 (20.7) [5.9–35.4]	4 (14.8) [14.2–28.2]	13 (59.1)	1 (0.6) [0.0–1.6]	2 (25)
Hind limbs	Medial	207 (34.3) [30.5–38.1]	131 (41.6) [36.1–47.0]	82 (65.2) [57.3–73.2]	–	–	7 (25.9) [9.4–42.5]	13 (56.5)	–	0 (0)	0 (0)	2 (33.3)
	Interdigital	–	–	–	61	48	–	–	23	–	–	–
	Lateral	397 (65.7) [61.9–69.5]	184 (58.4) [53.0–63.9]	44 (34.8) [26.8–42.7]	–	–	20 (74.1) [57.5–90.6]	10 (43.5)	–	9 (100)[a]	17 (100)[a]	4 (66.7)
	Total	604 (79.6) [76.7–82.5]	315 (81.4) [77.5–85.3]	126 (72.6) [66.3–79.0]	61 (85.9) [77.8–94.0]	48 (85.7) [76.5–94.9]	27 (81.8) [68.7–95.0]	23 (79.3) [64.6–94.1]	23 (85.2) [71.8–98.6]	9 (40.9)	17 (94.5) [83.9–100.0]	6 (75)
Overall total[*]	759	387	178	71	56	33	29	27	22	18	8	

[†] Confidence interval just reported for statistically significant findings

[a] All lesions were found at this location for the corresponding limbs

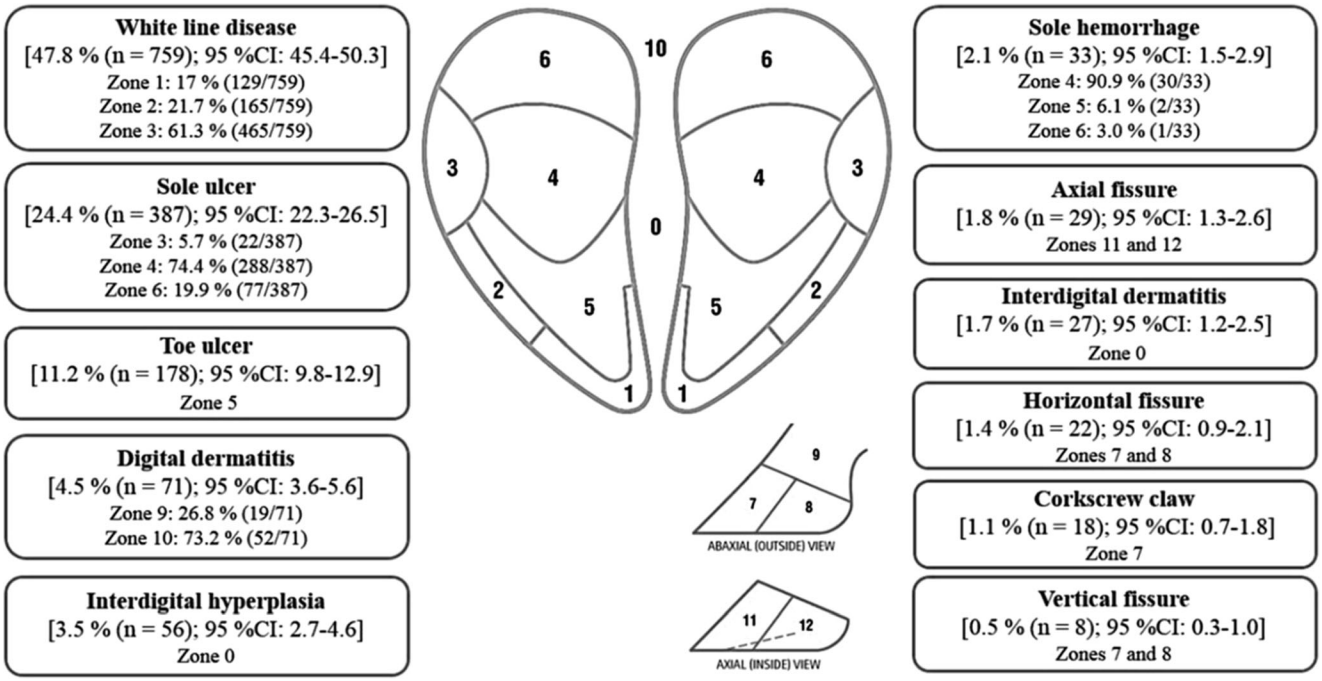

Fig. 2 Overall frequency of each foot lesion (in brackets) and affected claw zones in 1120 bovines from 71 herds in the Province of Antioquia (Colombia), 2011–2016. Figure courtesy of Zinpro® Corporation (Eden Prairie, MN, USA)

n = Number of lesions reported and identified, and a percentage is presented considering as denominator the total of foot lesions observations (1588)

region (zone 3) of lateral claws (Sanders et al. 2009). Moreover, there were fewer WLD lesions reported in front and hind medial claws were found. The white line is the flexible junction that lies between the wall and the sole. It is a heterogeneous makeup of tubular, non-tubular, and cap horn, which makes it weaker and subject to separation and penetration by foreign material. The most common site for white line lesions is the abaxial heel region, in part because of concussion associated with heel strike during locomotion (Sanders et al. 2009). Distribution of sole and toe ulcers found in our study is in agreement with the literature. Sole ulcers are typically found in zone 4 of the hind lateral claws and, less frequently, on the front medial claws (Sanders et al. 2009). Toe ulcers can affect both front and hind limbs in zone 5 (Blowey and Weaver 2011). In this study, hind medial claws were the most commonly affected. This may be due to mechanical trauma, as sequelae of laminitis (Greenough 2007) or as a consequence of abrasive flooring conditions (Shearer and van Amstel 2017). Sole hemorrhage in the typical site (heel-sole junction) is regarded as an indicator of contusion and potentially an early sign of sole ulcer (van Amstel and Shearer 2006). Consistent with other reports, sole hemorrhage was observed more frequently on the hind lateral claws (Blowey and Weaver 2011). Some consider digital and interdigital dermatitis to be indistinguishable (Blowey and Weaver 2011). It is not uncommon for digital dermatitis to be identified in the interdigital space of the hind limbs (Knappe-Poindecker et al. 2013). Our study found that the digital location was more frequent than the interdigital, and mainly related to the hind limbs. This can be due to the evolution of the foot lesion before being examined and treated by the hoof trimmer. Corkscrew claw was found only on lateral claws of the hind limbs. The lateral claw of both limbs is frequently affected by this condition (Blowey and Weaver 2011).

Other studies on lameness disorders in Colombia have been conducted by Benavides et al. (2012) who reported lesions associated with subclinical laminitis in first-lactation cows in 11 herds, in the municipality of Pasto (Nariño). Heel erosion was the most frequent foot lesion (53.8%; 21/39), followed by sole hemorrhage (46.1%; 18/39) and WLD (28.2%; 11/39). The authors of this report in Nariño refer to heel erosion as a "moist and devitalized tissue of the heel resulting in the formation of surface grooves." This case definition is slightly different from the Zinpro® brochure's, which may explain the differences found when compared to our findings. Álvarez et al. (2017) reported on foot lesions in dual-purpose cows in the province of Córdoba. Corkscrew claw was the most frequent foot lesion observed (36.5%; 62/170), followed by interdigital hyperplasia (17.1%; 29/170) and sole ulcer (4.7%; 8/170). A hereditary etiology must be considered to explain its high frequency (Blowey and Weaver 2011). Borrero and Córdoba (2015) reported foot lesions from cows in one dairy herd in Bogotá (Cundinamarca). Sole hemorrhage (86.5%; 77/89) was the most frequent lesion, followed by WLD (4.5%; 4/89) and heel erosion (2.5%; 2/89). In a second study, Borrero et al. (2015) reported on foot lesions observed

in cows from four dairy herds in Bogotá (Cundinamarca), using a classification previously reported (Guard 2001; Nordlund and Cook 2004). The authors reported that the most prevalent lesion was sole hemorrhage (79.4%; 367/462), horn overgrowth (15.2%; 70/462), and WLD (2.8%; 13/462). More recently, Cadavid et al. (2015) reported on foot lesions in cows from 71 herds in 13 municipalities located in four regions of the Province of Antioquia (2010–2015). Twenty-three different foot lesions were reported. White line disease abscesses (consider into the case definition of WLD in our study) were the most frequent foot lesion (26.2%; 635/2420), followed by sole abscess (considered to a sole ulcer in our study; 10.5%; 253/2420) and laminitis (8.4%; 202/2420). So far, our study is the first in Colombia to use an internationally approved case definition for foot lesion identification in cattle, thus allowing comparisons with others worldwide.

The increasing number of foot lesions reported resulted from an increase in herds requesting foot care and claw trimming services. Herds requesting foot care services increased from 35 herds in 2011–2013 to 84 by 2016. In addition, the motivation of farmers to prevent foot lesions in cattle and interest in hiring an outside or off-farm trimmer to carry out these procedures have also increased in recent time. The distribution of foot lesions between rainy and dry seasons did not differ statistically. However, the lack of difference observed may be a consequence of the origin of the dataset. The reported cases were from regular attended hoof trimming visits and not from a randomized sample-based study. According to our results, August, September, October, and December are significantly different from the rest of the months in terms of the number of reports of foot lesions. August, October, and December are considered dry months in Colombia. One possible explanation is the tendency of the farmers to "prepare" the animals for the rainy months by preventive hoof trimming (Jubb and Malmo 1991).

The greater proportion of cases in dairy herds, compared to dual purpose and meat systems, and of females compared to males is most likely the consequence of these populations representing the great majority in the four regions of the Province of Antioquia included in this study. Dual purpose and meat production are mainly located in the low tropic areas, which were not included in this study.

We acknowledge that there are some limitations in this study. Given the descriptive nature of this investigation and the origin of the dataset, it is not possible to draw a conclusion regarding causality, prevalence, or risk factors assessment. The lack of the total number of trimmed-animals during the study reduces possible analysis of these parameters. Although we endeavored to reduce variation and error within the database, it is important to note the following when drawing inferences from this data: (1) it was obtained by convenience sampling, (2) data were collected by hand and then entered into worksheets increasing the possibility of transcription errors, and (3) the hoof trimmer's experience with lesion identification and recording have continued to evolve through the years.

Although awareness about prevention of foot lesions has been increasing, producers often consult the hoof trimmer when they recognize that lameness has worsened. In some cases, it is not possible to define the primary lesion since the original problem has progressed to a more complex condition. This could have led to under-reporting of thin soles in this study. Van Amstel et al. (2004) suggest that adult cows with a flexible sole—particularly at the toe—detected by using finger pressure must be considered as affected with thin soles. It is often not reported as such, because according to the hoof trimmer, it is a "very common" finding during examination of animals participating in this study. Thin sole is usually a consequence of excessive sole horn wear because of abrasive flooring surfaces and soft claw horn resulting from the higher moisture content in claw horn. Therefore, "thinning" of the sole predisposes to contusions, ulcers, or vascular injury in general (Shearer et al. 2005).

Electronic records are a practical tool for the improvement of data collection, because they allow hoof trimmers to enter trimming data faster and easier than writing reports by hand. This approach also simplifies the creation of trimming reports for the farmer (DeFrain et al. 2013) and eases disease surveillance, risk factor assessment, benchmarking, and genetic improvement (Chapinal et al. 2013; Kofler 2013). Electronic recording also increases precision and efficiency of data collection by reducing error due to transcription errors and helps in standardizing foot lesion recognition (Shearer et al. 2005).

Authors conclude that this dataset provides a descriptive overview of foot lesions in cattle from Colombia, their distribution, and frequency. Although these data are from a limited area of the country, they are consistent with published and anecdotal reports of foot lesions in cattle in Colombia and worldwide. The authors suggest that there is a need for additional prospective research under Colombian dairy cattle management conditions to better understand the lameness and benefit of trimming intervention. Furthermore, we suggest that hoof trimmers and veterinarians should seek to combine their efforts to unify criteria on foot lesion identification and recording using an electronic data collection instrument. It is believed that this would help to provide a broader and more accurate perspective of the current distribution and frequency of foot lesions in Colombian cattle.

Compliance with ethical standards

Conflict of interest statement The authors declare that they have no conflict of interest.

Ethical standards All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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