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Cow- and herd-level factors associated with lameness in small-scale grazing dairy herds in Brazil

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ABSTRACT

This cross-sectional study aimed to assess lameness occurrence and to identify the associated risk factors in small-scale grazing dairy herds. Forty four farms (mean lactating herd size was 42 cows, SD = 11.2, range: 28–74) located in the south of Brazil were visited twice, approximately 4 months apart, in 2015. Locomotion was scored in 1633 and 1836 cows at the first and second visit, respectively. Potential risk factors for lameness were assessed through inspection of cows and facilities, and a questionnaire for farmers about herd management practices. Multilevel logistic regressions, using herd as random effect, were fitted to investigate the cow-level risk factors for accumulated incident (not lame at the first visit but lame on the second), chronic (lame on both visits) and recovered (lame at the first visit but sound on the second) cases of lameness. A multilevel linear regression, using municipality as a random effect, was fitted for herd-level analysis. Cumulative lameness incidence between two visits (1110 cows in 41 herds) was 29.6% (range: 0–80); lameness prevalence (n = 44 herds) was 31% (10–70) and 35% (5–76) at the first and second visits, respectively. The odds of incident cases were greater in Holstein cows [odds ratio (OR) = 4.0, 95% confidence interval 2.1–7.6] compared with Jerseys, in cows in parities 2–3 (OR 2.5, 1.4–4.4) or > 3 (OR 6.6, 3.3–13.1) relative to parity 1, in cows having a low body condition score (BCS) of 2–2.75 or 3 on the first visit (OR 2, 1.1–3.7), and in cows with observed hoof abnormalities (OR 2.5, 1.3–4.7). Similar associations were found for chronic cases, with Holstein and crossbred cows having greater odds of lameness, compared to Jersey, and chronic cases being more likely in cows with increasing parity, with BCS at first visit of 2–2.75, and with presence of hoof abnormalities. Jersey or crossbred cows (OR 3.2, 1.3–8.1) and cows in parity 1–2 (OR 3.6, 1.6–8.4) had higher probability of recovery from lameness. Having a herd composed of Holstein cows was associated with 13.5% (CI 4.3–22.8) greater incidence of lameness (n = 35). For every 1 km/h increase in the average speed of movement of the herd to or from milking, lameness incidence increased by 5% (CI 0.1–10). Given that the occurrence of lameness was high there is great opportunity to reduce lameness in this population. This study highlights some management and prevention practices that may reduce lameness in these grazing herds.

1. Introduction

Lameness is a common issue that impairs the health and welfare of dairy cattle (Huxley et al., 2012; Potterton et al., 2012). Cows affected by lameness have lower dry matter intake and milk yield (Bach et al., 2007; Bicalho et al., 2008; Leach et al., 2012), lower risk of pregnancy (Alawneh et al., 2011; Bicalho et al., 2007), and increased risk of being culled (Bicalho et al., 2007). Economic losses in the affected herds are associated with treatment costs and especially with reduced productivity (Bruijnis et al., 2013; Huxley et al., 2012). Lameness is a clinical symptom that manifests as locomotion disturbance in dairy cows (O'Callaghan, 2002). Thus, visual indicators commonly used to identify an affected individual include asymmetric movement, rhythm and speed of gait, reduced weight bearing on the hooves, and abnormal postures (Flower and Weary, 2009).

Most cases of lameness originate from lesions of the lateral claws on the hind feet (Blowey and Weaver, 2011; Huxley et al., 2012). This may be explained partly by the asymmetric nature of bovine toes (lateral

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toes are longer than medial) (Muggli et al., 2016), which results in overloading on the softer parts of the lateral hind claws during normal gait (Van der Tol et al., 2003), and by changes in the load dissipation capacity of the sole soft tissues (i.e., corion and digital cushion) in cows with advancing age and stage of lactation (i.e., lower in older cows and after calving) (Bicalho et al., 2009; Lim et al., 2015; Newsome et al., 2017a; Räber et al., 2004). The action of traumatic forces might selectively affect the limbs of higher risk individuals and result in foot lameness (Green et al., 2014; Lim et al., 2015; Randall et al., 2015). The etiology of lameness is multifactorial and complex, but, in general, the interaction of two main factors appears to strongly influence the dynamics of lameness related to claw horn disruption.

The first group of factors are housing and management issues that might increase mechanical stress on the foot, such as inadequate size of facilities, overstocking, inappropriate walking surfaces, and lying surface characteristics (Burow et al., 2014; Ranjbar et al., 2016; Solano et al., 2015, 2016; Westin et al., 2016). Further factors are the relation between physiological changes during the transition period and the nutritional management of the herd, including high milk yield, excessive and rapid body weight loss, and poor feeding management of cows around calving (Alawneh et al., 2014; Bicalho and Oikonomou, 2013; Dippel et al., 2009).

Access to pasture or loafing areas has been reported as protective for lameness in confined dairy cows (Gard et al., 2015; Hernandez-Mendo et al., 2007; Olmos et al., 2009). However, studies assessing lameness in grazing dairy herds are scarce (Alawneh et al., 2014; Ranjbar et al., 2016). The protective effect of grazing for lameness might be due to a reduction of risk for specific lesions or diseases (e.g., sole ulcer); however, some features of grazing systems may potentially increase lameness. The condition of paths, heat stress, or other management-related issues may increase the occurrence of lameness, by enhancing risk factors for some hoof pathologies. In fact, hoof lesions such as white line disease, sole injuries including bruising or penetration by an object, and axial disease are more common in grazing cows (Lawrence et al., 2011) while sole damage (e.g., sole ulcer) is associated with confined systems (Navarro et al., 2013). Access to pasture in cows housed in tie stalls was associated with higher prevalence of digital dermatitis, white line separation and interdigital fibroma (Cramer et al., 2009). Hence, risk factors for lameness, or the relative importance of specific exposures, might differ for cows managed in grazing systems. For this reason, exploring lameness prevalence and incidence and risk factors in grazing herds may help to identify specific recommendations for the control and prevention of lameness in pasture-based systems. The aim of this study was to assess lameness occurrence in small-scale grazing dairy herds and to identify the associated cow- and herd-level risk factors.

2. Materials and methods

The present cross-sectional study was carried out in 2015, in the western part of Santa Catarina State in Brazil. It was part of a larger study with multiple objectives including the identification of risk factors for peripartum diseases (Daros et al., 2017) and stakeholder views of lameness in grazing dairy herds (Olmos et al., submitted). The study report was conducted in compliance with the STROBE Veterinary Statement for reporting observational studies in epidemiology (Sargeant et al., 2016). All procedures outlined below were approved by the Ethics Committees on Research on Humans (Protocol # PP1237779) and Animals (Protocol # PP00949) of the Federal University of Santa Catarina, Brazil and the University of British Columbia Animal Care committee (Protocol # A15-0082).

The sample of herds was selected by convenience (Dohoo et al., 2003), with farmers recruited based on information provided by people working in the dairy sector in the region. To minimize selection bias, informants were only aware of the general objective of the study. Farms were selected based on the following criteria: a) herd size of at least 40 cows, b) farms with good accessibility from main urban centers in the region, c) cows housed on pasture for at least 16 h/d, c) use of dairy production, management and health records and d) farmer consent to participate in the study. From the initial group of 61 farmers that were invited to participate in the study, 8 declined and an additional 9 were excluded due to challenges associated with failing to identify a location where cows could be locomotion scored. The remaining 44 farms, located in 12 municipalities, were visited twice by two researchers accompanied by research assistants, to assess animal and environmental measures. The visits took place approximately 4 months apart during the summer/autumn and winter/spring months, respectively. For additional description of farm and cow management practices typical of this region, see Balcão et al. (2017) and Costa et al. (2013).

2.1. Animal-based evaluations

The same investigators visited each farm at the first and second visit, with each investigator responsible for taking the same measures on each of the visits. All lactating cows present in the farms at the time of each visit were examined. Cows were individually identified at the time of assessment. The hooves were inspected visually in the milking parlor and the presence of the superficial abnormalities was recorded, including interdigital skin hyperplasia, stage 4 digital dermatitis, scissor claw, horn cracks, horizontal and vertical fissures (Blowey and Weaver, 2011). Body condition score (BCS) was measured during milking using a categorical scale (1–5 points with 0.25 unit increments) (Edmonson et al., 1989). Locomotion scoring was done when the cows exited the parlor and were walking along a straight flat hard surface, using a five point scale, where 1 was sound and 5 extremely lame (Flower and Weary, 2006). The average speed (km/h) of herd movement was assessed when the farmer was moving cows to or from milking. Distance walked was determined using a digital pedometer (Onstep 400-Geonaute, Oxylane, France) held by one of the researchers walking behind the herd; the time when the first cow left pasture and the last cow arrived at the milk holding area or, alternatively, the first cow left the feeding area and the last cow entered the pasture was recorded. The researcher also recorded how the cows were moved, i.e., walking, motorized vehicles (e.g., motorcycle) or dogs, and also if the farmer pushed the cows when moving the herd (i.e., the farmer walked briskly behind the herd, made sounds or shouted, used sticks, or performed strong body movements intended to make the cows walk faster). For this predictor, data from the first visit were used to develop and test the method and data from the second visit were used for analytical purposes.

Information on milk yield by herd, parity, and days in milk of cows were collected from farm records, when available. Data on milk yield per herd was obtained from dairy company records at the farm.

2.2. Management and environment based evaluations

Data on routine management practices were collected through a face-to face interview conducted with farmers at the first visit. Open-ended questions were asked of the farmers and their answers were recorded with a smartphone using a predefined form built for this project (Kobotoolbox, 2014). Information was collected on milking routine, total farm area, grazing management, land area dedicated specifically to dairy production (perennial and annual pasture, or area planted with corn for silage). Given that records of specific feeding practices (amount of silage and concentrate fed per cow) and daily milk yield by cow were not routinely kept on the majority of farms, estimates of mean values per cow were obtained using the responses given by the farmers to the questionnaire.

Potential environmental risk factors for lameness were assessed through inspection of the milking area, feed bunk, paths and grazing areas. Use of any preventive measure for lameness was checked by reading through any available farm records to identify any event and treatment, hoof trimming, routine use of foot-baths. Questions were