Austral Journal of Veterinary Sciences

Austral J Vet Sci 57, e570115 (2025)
https://doi.org/10.4206/ajvs.57.15

SHORT COMMUNICATION

Prevalence and risk factors of foot lesions in a dairy cattle herd in the Huaura Valley, Peru

Néstor Chagray Ameri[1,2], Renzo Chagray Padilla[1], Yaneline Hidalgo Vasquez[2*], Carlomagno Velásquez Vergara[2], Rufino Maguiña Maza[2], Félix Airahuacho Bautista[2]

[1] Inversiones Pecuarias Granados SAC, Huacho, Perú.

[2] Departamento Académico de Zootecnia, Facultad de Ingeniería Agraria, Industrias Alimentarias y Ambiental, Universidad Nacional José Faustino Sánchez Carrión, Huacho, Perú.

Article History
Received: 29.06.2025
Accepted: 21.10.2025
Published: 26.11.2025

Corresponding author
*Yaneline Hidalgo Vasquez
yhidalgo@unjfsc.edu.pe

ABSTRACT. Foot lesions are a major cause of culling in dairy cows, resulting in significant economic losses. This study aimed to determine the prevalence and factors associated with foot lesions in a dairy herd in the Huaura Valley, Peru. To this end, 1,781 functional hoof trimming records (2013-2021) were analyzed. The results showed a significant downward trend ($P < 0.05$) in the overall prevalence, with an annual average of 35.5%. This began at 24.7% (2013), peaked at 56.5% (2017), and decreased to 15.3% (2021). Non-infectious lesions (26.1%) were more frequent than infectious lesions (7.7%) ($P = 0.019$), with white line disease (37.1%) and digital dermatitis (38.9%) being predominant. The number of lactations was identified as a critical risk factor (OR: 1.98; 95% CI: 1.72-2.29), ranging from 17.6% in first-lactation cows to 65.5% in cows with four or more lactations. No statistically significant association was found between the climatic period of the year and the occurrence of foot lesions ($\chi^2 = 0.23$; gl = 1; $P < 0.63$). In conclusion, this study showed a significant temporary reduction in lesions, with the number of calvings being the most critical risk factor, unlike the climatic period, which was not a determining factor in the occurrence of foot lesions.

Keywords: dairy cattle, hoof injury, etiology, calving season

INTRODUCTION

Foot lesions pose a significant economic and animal welfare challenge in the dairy industry, leading to increased production costs due to veterinary treatments and the need for additional personnel (Salem *et al.*, 2024). These injuries trigger a vicious cycle of productive consequences: they reduce feed intake, cause loss of body condition, decrease milk production, and affect reproductive rates, requiring up to 1.6 more services per conception (Hernández *et al.*, 2001). This combination of factors accelerates premature culling, shortening the productive life by up to 15 months (McMullen *et al.*, 2021).

The etiology is multifactorial, involving nutritional, environmental, management (Solano-López *et al.*, 2018), genetic (Oberbauer *et al.*, 2013), and physiological (Griffiths *et al.*, 2020) factors. The global prevalence varies between 5-30% (Labrada-Velázquez *et al.*, 2020), with regional differences in South America: Uruguay (23-24%; Ciamarella *et al.*, 2018), Argentina (31.7%; Burgos *et al.*, 2021), Chile (33.12%; Flor & Tadich, 2008), and Brazil (36%; Ebling *et al.*, 2019).

In Peru, the incidence of foot lesions has gradually increased. In the Lima dairy basin, it accounted for 3% of culling causes in the early 2000s (Orrego *et al.*, 2003), increasing to 9.7% a decade later in the Huaura Valley, where it became the third leading cause of culling (Velásquez, 2019). Therefore, it is imperative to identify the risk factors associated to this condition to implement effective prevention strategies. This study aimed to determine the prevalence and factors associated with foot lesions in a dairy herd in the Huaura Valley, Peru.

MATERIALS AND METHODS

Location

The study was conducted on a dairy farm located in the province of Huaura, Department of Lima, Peru (10°56'31"S 77°38'29"W 30 m above sea level). This region is characterized by a climate with an annual temperature range of 14-27 °C, relative humidity of 67-92%, and average annual precipitation of 1 mm.

The cows were kept in an open barn with dirt-floored pens (no free-stall system was used). Each pen had cement aprons in the feeding and drinking areas. The walkways and resting areas were dirt, whereas the waiting room and milking parlor had floors covered with non-slip rubber.

The average population was 558 Holstein cows in production. The herd's productivity reached 12,000 kg of milk per cow in 305 d of lactation. The feeding program consisted of a forage-based diet (55% dry matter), mainly fresh chopped corn and/or corn silage, supplemented with concentrates.

Assessment of foot injuries

A total of 1,781 records of foot lesions collected over nine consecutive years (2013–2021) were analyzed as part of a program integrated into the barn's health calendar. The preventive functional trimming protocol included trimming all newly calved cows at seven days postpartum, along with two scheduled trims per year for lactating cows: one during the warm period and another during the cold period. The standardized Dutch technique (González & de Prado, 2018; Zinpro Corp., 2019) was applied for all procedures. An experienced bovine podiatrist performed all procedures during the nine-year study period, ensuring consistency in the application of the technique.

The evaluated factors associated with the occurrence of foot lesions were: a) lactations: classification by number of lactations (first, second, third, and four or more); b) climatic period: according to the region's meteorological conditions: i) warm period (November–April), characterized by maximum temperatures and high relative humidity, and ii) cold period (May–October), characterized by lower temperatures and distinctive environmental conditions; and c) time coverage: analysis of nine consecutive years (2013–2021), covering 108 months of continuous recording, was conducted to assess trends and temporal variations.

Parameters evaluated

The indicators defined for the analysis were: a) overall prevalence of foot lesions (2013–2021): calculated as the number of cows with at least one lesion during the entire study period divided by the sum of the annual average herd populations, expressed as a percentage; b) annual prevalence: calculated for each year by summing the number of cows with at least one lesion across the 12 months and dividing by the average annual herd population; c) prevalence by climatic period: calculated similarly, grouping the months into two predefined periods (warm and cold); d) prevalence by number of lactations: calculated within each stratum of number of births: 1, 2, 3, ≥4; e) relative frequency of lesions classified according to their etiology: non-infectious: white line disease (W), heel ulcer (S), plantar hemorrhage (H), plantar ulcer (U), axial fissure (X), plantar ulcer (T), and soft sole (Z), and infectious: digital dermatitis (D), heel erosion (E), interdigital abscess (F), and interdigital dermatitis (I).

Data analysis

The unit of analysis was the cow by trimming date (month-year). To calculate the monthly prevalence, each cow with at least one foot lesion was considered a positive case, regardless of the number of lesions or affected hooves. Each observation was considered an independent record for calculating the monthly and annual prevalence, as the focus of the study was to describe the temporal dynamics of prevalence at the herd level. The prevalence of foot lesions was calculated using descriptive statistics and expressed as proportions. The association between climatic period and the occurrence of lesions was evaluated using a chi-square test of independence, while the relationship between lactations and the prevalence of lesions was analyzed using a chi-square test of trends. The Mann-Kendall test was applied to determine whether there was a significant trend in the time series (2013-2021). All analyses were performed at a significance level of $\alpha = 0.05$. Data processing was performed using SAS statistical software (version 9.4).

RESULTS AND DISCUSSION

Prevalence of foot lesions

The longitudinal analysis (2013-2021) revealed an overall prevalence of 35.5% of foot lesions. The variability reported between countries (Solano *et al*., 2015; Arrieta *et al*., 2021; Labrada-Velázquez *et al*., 2020) reflects differences in management practices, environmental conditions, and diagnostic protocols, highlighting the need to standardize epidemiological criteria in order to perform comparative analyses (Cramer *et al*., 2009).

The temporal trend showed a significant decrease ($P < 0.05$) (Figure 1). The annual prevalence was 24.7% in 2013, peaked at 56.5% in 2017 (a 131% increase compared to 2013), and reduced to 15.3% in 2021 (a 62% decrease compared to the peak). These changes may be related to the progressive management adjustments implemented in the barn since 2013, which were aimed at optimizing productivity.

In the early years (2013–2015), interventions aimed primarily at increasing milk yield (e.g., adoption of totally mixed rations with more frequent feeding, inclusion of corn silage, and the installation of cooling systems) were associated with a rise in production from 11,256 to 11,991 kg per 305-day lactation (Hidalgo-Vasquez *et al*., 2021). However, these same changes coincided with a progressive increase in hoof lesion prevalence, reaching 47.8% in 2015. This could be explained by a higher intake of fermentable carbohydrates, which reduces rumen pH and decreases saliva production, as rumination is less stimulated by low-fiber forage (Passos *et al*., 2023). Moreover, cooling systems may have increased environmental humidity, promoting horn softening, accelerating hoof wear, and facilitating pathogen entry (Cardona & Cano, 2003; Solano-López *et al*., 2018). In subsequent years, additional preventive measures, including functional hoof trimming and adjustments in feeding management, likely contributed to mitigating these risks. Thus, while early productivity-driven changes may have increased lesion prevalence, the integration of preventive strategies over time resulted in a sustained reduction.

The highest prevalence peak (56.5%) was recorded in July 2017, which was additionally attributed to the occurrence of the Coastal El Niño phenomenon. This event increased the ambient temperature (from 28–30 °C to 32–35 °C) and relative humidity (from 70–75% to 80–85%) along the Peruvian coast (Multisectoral Committee for ENFEN, 2017), resulting in heat stress for livestock. This combination of factors compromised the mechanical resistance of the corneal tissue, deteriorating its structural integrity and making it more susceptible to injury.

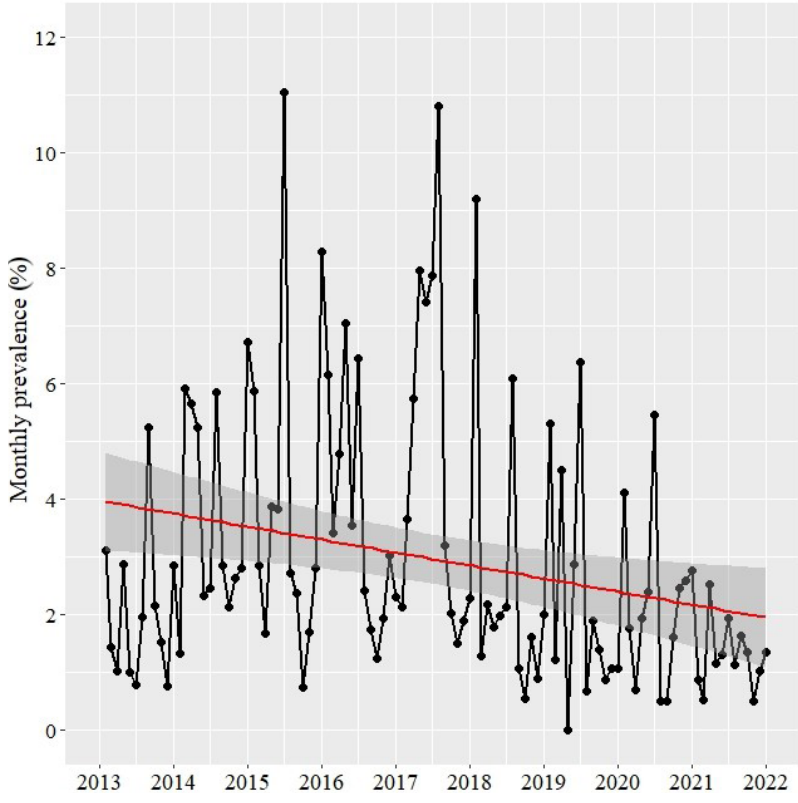

Figure 1.
Temporal dynamics of foot lesions in dairy cows: monthly distribution and decreasing trend in the Huaura Valley, Peru (2013–2021).

From 2018 to 2021, the observed reduction in foot lesion incidence coincided with the progressive implementation of management, infrastructure, and feeding practice adjustments aimed at mitigating the previously identified risk factors. These changes likely offset the effects of environmental and nutritional factors, resulting in a sustained decline in their prevalence.

Etiology of foot injuries

A significant association was identified between the etiology and presentation of foot injuries (χ^2 = 127, df = 48, P < 0.0001). Non-infectious disorders (77.2%) predominated over infectious etiologies (22.8%), which aligns with reports from intensive systems in Canada (Arango-Sabogal *et al.*, 2020) and pastoral systems in Ireland (Somers & O'Grady, 2015). However, these results contrast with those of studies on subtropical systems in Brazil (Costa, 2018), which documented a balanced proportion of both types (52.9% vs. 47.1%). These divergences suggest the influence of management factors, diagnostic protocols, and environmental conditions that are specific to each production system.

Non-infectious lesions exhibited a notable downward trend (P = 0.019, Mann-Kendall test). Initially, they were prevalent at 18.33% in 2013, peaked at 45.37% in 2017, and decreased to 13.71% in 2021. This decrease coincided with improvements in management and nutrition, which were implemented beginning in 2013. The average annual prevalence was highest for white line disease (W: 9.7%), followed by foot hemorrhage (H: 3.9%), foot ulcer (U: 2.6%), axial fissure (X: 2.3%), heel ulcer (T: 1.6%), and soft foot (Z: 0.6%). The annual distribution of both infectious and non-infectious lesions is presented in Table 1. These values were lower than those reported in the US (Sanders *et al.*, 2009) but were consistent with previous local studies (Cáceres, 2017). The high prevalence of non-infectious lesions may be associated with the high consumption of grains, which can cause rumen acidosis and, subsequently, subclinical laminitis (Alvergnas *et al.*, 2019). This condition can compromise digital structures and lead to ulcerations and erosions (Greenough *et al.*, 2014; Gonzalez & de Prado, 2018).

Infectious lesions exhibited a non-significant reduction (P = 0.064, Mann-Kendall test) from 8% in 2013 to 3% in 2021. Their prevalence was lower than that reported in other South American countries (10%-47%; Costa *et al.*, 2018). The main pathologies identified were digital dermatitis (D: 3.0%), heel erosion (E: 2.1%), interdigital abscess (F: 1.7%), and interdigital dermatitis (I: 0.9%). These values are higher than those documented in Argentina (Confalonieri *et al.*, 2008) but are significantly lower than those in tropical regions (Costa *et al.*, 2018; Jourdan & Rivera, 2019). The lower prevalence observed in this study is comparable to that reported by Orrego-Villacorta (2018) in Peru.

The lack of statistical significance in the trend of infectious lesions (P = 0.064) may be due to the low baseline

Table 1.
Prevalence of foot lesions in dairy cows according to etiology (infectious vs. non-infectious) in a dairy barn in the Huaura Valley, Peru (2013-2021).

Source of injury	Pathology	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual average
Non-infectious	White line disease (W)	4.7	12.9	13.9	14.5	15.7	7.4	8.5	5.9	3.7	9.7
	Heel ulcer (S)	5.3	9.5	6.7	9.0	10.7	3.2	1.2	1.7	1.3	5.4
	Sole hemorrhage (H)	3.8	4.4	6.5	1.9	2.9	2.5	3.8	7.3	1.8	3.9
	Sole ulcer (U)	1.0	3.3	3.0	4.2	4.1	2.0	3.5	1.0	1.5	2.6
	Axial fissure (A)	1.8	2.4	3.3	2.1	2.5	1.6	2.4	2.6	1.8	2.3
	Plantar ulcer (T)	1.2	1.5	0.9	0.9	3.0	2.3	2.1	0.9	1.5	1.6
	Soft sole (Z)	0.4	0.2	1.1	0.7	2.0	0.7	0.2	0.2	0.2	0.6
Infectious	Digital dermatitis (D)	1.2	1.8	1.9	3.2	7.3	5.4	3.1	2.3	0.5	3.0
	Heel erosion (E)	4.2	5.1	5.0	2.8	1.2	0.2	0.0	0.0	0.0	2.1
	Interdigital abscess (F)	0.4	1.8	0.7	2.5	5.0	2.2	0.7	1.6	0.8	1.7
	Dermatitis	0.2	0.7	0.6	1.1	1.2	1.1	0.7	0.9	1.3	0.9

prevalence and the influence of unmeasured intrinsic factors, such as genetic resistance or adaptive immunity. This reduces statistical power, meaning larger sample sizes are necessary to detect significant changes. Although the preventive program demonstrated a favorable effect consistent with a downward trend, its impact may have been limited by these uncontrolled variables.

This finding differs from previous literature that emphasizes the role of environmental factors and microbial load (Alvergnas *et al*., 2019). However, this does not invalidate these principles. In fact, it suggests that in contexts with low environmental variability and optimized management, such as in the present study, intrinsic animal factors may play a larger role in the epidemiology of infectious lesions.

Number of lactations and foot lesions

The prevalence of foot lesions increased progressively and significantly with the number of lactations: 17.6% for the first lactation, 32.0% for the second, 53.4% for the third, and 65.5% for the fourth or more (OR = 1.98, 95% CI = 1.72–2.29, $P < 0.001$; Figure 2). This finding is consistent with previous reports in the literature. In a study conducted in Canada with 141 barns, Solano *et al*. (2015) associated a higher number of lactations with an increased risk of developing foot lesions. Cows in their second, third, and fourth or more lactations were 1.6, 3.3, and 4 times more likely to have lesions, respectively, compared to cows in their first lactation.

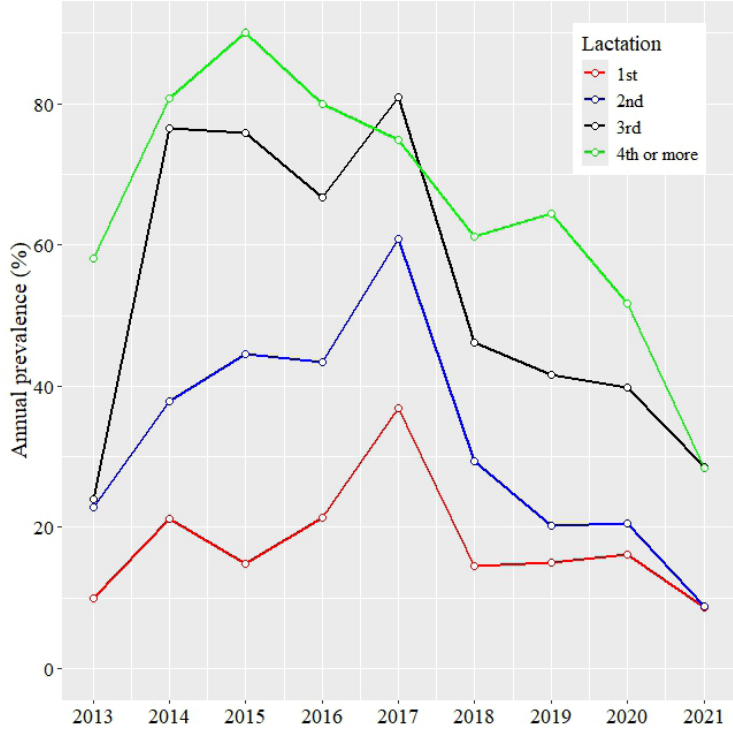

Figure 2.
Distribution of foot lesions, according to number of lactations, in a dairy barn in the Huaura Valley, Peru (2013-2021).

The present study found that cows with four or more lactations were 1.98 times more likely to have foot lesions than cows in their first lactation. Additionally, the risk of lesions increased by 19% with each additional lactation. These results reinforce previous findings, such as those of Costa (2018), who reported that 10-year-old cows are four times more likely to develop these lesions than three-year-olds.

Hoof lesions in cows with a higher number of lactations are associated with anatomical, metabolic, and environmental factors. These cows exhibit excessive hoof growth due to a lack of trimming, atrophy of the digital pad (which reduces shock absorption capacity), and prolonged exposure to intensive environments (which increases lesion recurrence). The risk peaks during the third lactation, which coincides with peak milk production and metabolic stress (Jourdan & Rivera, 2019).

Climatic period and Foot Lesions

No statistically significant association was found between the climatic period and the occurrence of foot lesions (χ^2 = 0.23; df = 1; $P > 0.63$). A slightly higher prevalence was observed during the warm period (18.6%) than during the cold period (16.9%), but the difference was minimal. These results contrast with those of Sanders *et al.* (2009), who reported a prevalence that was 3.2 times higher in summer (2.37 cases per 1,000 cow-days) than in winter (0.75 cases per 1,000 cow-days). The lack of a significant association between the climatic period and lesion occurrence may reflect the relatively small temperature variation in the study region (approximately 15 °C), which probably attenuated the effect of the climatic period as a risk factor. These findings underscore the preponderance of intrinsic factors (e.g., number of lactations) over environmental factors in the development of foot lesions in dairy cows.

CONCLUSIONS

This study revealed a high prevalence of foot lesions, primarily non-infectious. The number of breastfeeding periods was identified as the primary risk factor, demonstrating a positive and significant association. In contrast, the climatic period did not show a significant influence within the evaluated system. The progressive decrease in prevalence suggests that the hoof health maintenance program has effectively controlled these conditions.

Conflict of interest statement

The authors declare that they have no conflicts of interest.

Data availability statement

The data supporting the conclusions of this study are available upon request and with the authors' permission.

Contribution of authors

Research direction: N.CH.A., data collection: R.CH.P., data analysis and interpretation: Y.H.V., final drafting and revision: C.V.V., preparation of tables and figures: F.A.B., data review: R.M.M. All authors have read and approved the final version of the manuscript.

Funding

This research was self-funded.

Acknowledgments

The authors would like to thank the company "Inversiones Pecuarias Granados SAC" for providing access to the facilities and data necessary for this study.

REFERENCES

Alvergnas, M., Strabel, T., Rzewuska, K., & Sell-Kubiak, E. (2019). Claw disorders in dairy cattle: Effects on production, welfare and farm economics with possible prevention methods. *Livestock Science*, *222*, 54-64. https://doi.org/10.1016/j.livsci.2019.02.011

Arango-Sabogal, J. C., Desrochers, A., Lacroix, R., Christen, A. M, y Dufour, S. (2020). Prevalence of foot lesions in Québec dairy herds from 2015 to 2018. *Journal of Dairy Science*, *103*(12), 11659-11675. https://doi.org/10.3168/jds.2020-18191

Arrieta, L. M., Cruz, J. M., y González-Herrera, L. G. (2021). Enfermedad podal en bovinos: Prevalencia y asociación con algunas variables. *Revista de la Facultad de Medicina Veterinaria y de Zootecnia*, *68*(1), Article 1. https://doi.org/10.15446/rfmvz.v68n1.97257

Burgos, C. M., Gallo, L. M., Van Schaik, G., Fernández, H., Cattaneo, M., & Signorini, M. L. (2021). Prevalence of lameness and hoof lesions in dairy cows in the main livestock region of Argentina. *Spanish Journal of Agricultural Research*, *19*(2), e0603. https://doi.org/10.5424/sjar/2021193-17267

Cáceres, O. H. S. (2017). *Frecuencia de úlcera de suela en ganado bovino sometido a recorte funcional en establos de la Cuenca lechera de Lima* [Tesis de pregrado, Universidad Científica del Sur]. https://repositorio.cientifica.edu.pe/handle/20.500.12805/481

Cardona, J., y Cano, N. (2003). Alteraciones digitales en el ganado bovino del trópico bajo. *Revista MVZ Córdoba*, *8*(1), 249-253. https://revistamvz.unicordoba.edu.co/article/view/1048

Ciamarella, F., García, P., Pérez, W., Burgues, P., y Lago, A. (2018). Prevalencia de lesiones podales en bovinos lecheros de Uruguay. *Veterinaria (Montevideo)*, *54*(209), 6-13. https://www.revistasmvu.com.uy/revista/54/209

Comisión Multisectorial encargada del Estudio Nacional del Fenómeno del Niño, ENFEN. (2017, julio). Informe Técnico Extraordinario N° 001-2017/ENFEN: El Niño Costero 2017. https://www.dhn.mil.pe/archivos/oceanografia/enfen/nota_tecnica/01-2017.p

Cramer, G., Lissemore, K., Guard, C., Leslie, K. & Kelton, D. (2009). F Herd-level risk factors for seven different foot lesions in Ontario Holstein cattle housed in tie stalls or free stalls. *Journal of Dairy Science*, *92*(4), 1404-1411. https://doi.org/10.3168/jds.2008-1134

Confalonieri, O., Soraci, A. L., Passucci, J. A., Rodríguez, E. M., Becaluba, H. M., y Tapia, M. O. (2008). Prevalencia y detección de factores de riesgo de patologías podales y su influencia en la producción láctea en bovinos de la cuenca lechera. *Analecta Veterinaria*, *28*(2), 15-20. http://sedici.unlp.edu.ar/handle/10915/11221

Costa, J. H. C., Burnett, T. A., von Keyserlingk, M. A. G., Hötzel, M. J. (2018). Prevalence of lameness and leg lesions of lactating dairy cows housed in southern Brazil: Effects of housing systems. *Journal of Dairy Science*, *101*(3), 2395-2405. https://doi.org/10.3168/jds.2017-13462

Ebling, R., Krummenauer, A., Machado, G., Zeni, D., Carazzo, L., y Leal, M. (2019). *Prevalencia y distribución de lesiones en las pezuñas en vacas lecheras criadas en cubículos libres.* Semina: Ciencias Agrarias. https://doi.org/10.5433/1679-0359.2019V40N1P239

Flor, E, y Tadich, N. (2008). Claudicaciones en vacas de rebaños lecheros grandes y pequeños del sur de Chile. *Archivos de medicina veterinaria*, *40*(2), 125-134. https://dx.doi.org/10.4067/S0301-732X2008000200003

González, A., & de Prado, A. (2018). *Cattle Lameness.* Recuperado de https://www.wavegoodbyetopain.co.uk/foot-anatomy-and-biomechanics.html

Greenough, P. R., Schugel, L. M., & Johnson, A. B. (2014). *Problemas de patas en bovinos.* USA: Zinpro Corporation.

Griffiths, B., Mahen, P., Hall, R., Kakatsidis, N., Britten, N., Long, K., Robinson, L., Tatham, H., Jenkin, R. & Oikonomou, G. (2020). Prospective cohort

study on the development of claw horn disruption injuries in dairy cattle; deepening our understanding of the role of the digital cushion. *Frontiers in Veterinary Science*, *7*:440. https://doi.org/10.3389/fvets.2020.00440

Hernández, J., Shearer, J., & Webb, D. (2001). Effect of lameness on the calving-to-conception interval in dairy cows. *Journal of the American Veterinary Medical Association*, *218* (10), 1611-1614 https://doi.org/10.2460/JAVMA.2001.218.1611

Hidalgo-Vasquez, Y. N., García Salas, M. E. C., Gutiérrez Reynoso, G. A., y Chagray Ameri, N. H. (2021). Tendencia genética y fenotípica de la producción de leche: caso de un establo comercial del valle de Huaura, Perú. *Ciencia y Tecnología Agropecuaria*, *22*(1), e1892. https://doi.org/10.21930/rcta.vol22_num1_art:1892

Jourdan, J. N., & Rivera, G. A. (2019). *Estudio observacional de afecciones podales en un tambo comercial del departamento de Colonia* [Tesis de grado, Universidad de la República Uruguay)]. https://www.colibri.udelar.edu.uy/jspui/handle/20.500.12008/25749

Labrada-Velázquez, A., Miranda Cabrera, I., Rosete Millar, A., y González Díaz, A. (2020). Factores de riesgos asociados a la prevalencia de patologías podales en vacas Siboney de Cuba. *Revista de Salud Animal*, *42*(3). http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0253-570X2020000300005&lng=es&nrm=iso&tlng=en

McMullen, C., Laven, R., & Huxley, J. (2021). The impact of lameness on the lifespan of dairy cows: A meta-analysis. *Journal of Dairy Science*, *104*(11), 11830-11839. https://doi.org/10.3168/jds.2021-20387

Oberbauer, A., Berry, S., Belanger, J., McGoldrick, R., Pinos-Rodriquez, J. & Famula, T. (2013). Determining the heritable component of dairy cattle foot lesions. *Journal of Dairy Science*, *961*, 605-613. https://doi.org/10.3168/jds.2012-5485

Orrego, J., Delgado, A., y Echevarría, L. (2003). Vida productiva y principales causas de descarte de vacas Holstein en la Cuenca de Lima. *Revista de Investigaciones Veterinarias del Perú*, 14 (1), 68-73. http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1609-91172003000100012&lng=es&tlng=es

Orrego-Villacorta L. (2018). *Factores de crianza para la presentación de dermatitis digital bovina* [Tesis de grado, Universidad Científica del Sur]. https://repositorio.cientifica.edu.pe/handle/20.500.12805/740

Passos, L. T., Bettencourt, A. F., Ritt, L. A., Canozzi, M. E. A., Fischer, V. (2023). Systematic review of the relationship between rumen acidosis and laminitis in cattle. *Research in Veterinary Science*. *161*, 110-117. https://doi.org/10.1016/j.rvsc.2023.06.001

Salem, S., Monir, A., Abdallah, H., Mahmoud, A., Elsheikh, H., Refaai, W., Ahmed, A., Elsheikh, H., El-Sheikh, M. & Mesalam, A. (2024). Digital dermatitis in dairy cattle in Egypt: herd-level risk factors and prevalence of Treponema spp. in lesion M-scores. *The Veterinary Journal*, *309*, 106289. https://doi.org/10.1016/j.tvjl.2024.106289

Sanders, A. H., Shearer, J. K., & De Vries, A. (2009). Seasonal incidence of lameness and risk factors associated with thin soles, white line disease, ulcers, and sole punctures in dairy cattle. *Journal of Dairy Science*, *92*(7), 3165-3174. https://doi.org/10.3168/jds.2008-1799

Solano, L., Barkema, H. W., Pajor, E. A., Mason, S., LeBlanc, S. J., Zaffino Heyerhoff, J. C., Nash, C. G. R., Haley, D. B., Vasseur, E., Pellerin, D., Rushen J., de Passillé A. M., & Orsel, K. (2015). Prevalence of lameness and associated risk factors in Canadian Holstein-Friesian cows housed in freestall barns. *Journal of Dairy Science*, *98*(10), 6978-6991. https://doi.org/10.3168/jds.2015-9652

Solano-López, M., Vargas-Leitón, B., Saborío-Montero, A., & Pichardo-Matamoros, D. (2018). Genetic and environmental factors that have an effect in dairy cattle foot injuries in Costa Rica. *Agronomía Mesoamericana*, *29*(1), 123. https://doi.org/10.15517/ma.v29i1.28027

Somers, J., & O'Grady, L. (2015). Foot lesions in lame cows on 10 dairy farms in Ireland. *Irish Veteterinary Journal*, *68*, 10. https://doi.org/10.1186/s13620-015-0039-0

Velásquez, C. (2019). Causas de descarte en tres establos lecheros del valle de Huaura, 2005 - 2010. *Revista de Investigación Científica Tayacaja*, *2*(1), 52-58. https://doi.org/10.46908/rict.v2i1.38

Zinpro Corp. (2019). *Dairy Hoof Trimming Guide*. Recuperado de https://www.zinpro.com/dairy-cow-hoof-trimming-guide/?lang=es