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Original article

LAMENESS PREVALENCE AND ASSOCIATED RISK FACTORS IN DAIRY CATTLE IN OUM EL BOUAGHI AND KHENCHELA, NORTHEAST ALGERIA

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Summary

Baghezza, S., A. Azizi, K. Ghougal, M. Belaidi & A. A. Foughali, 2025. Lameness prevalence and associated risk factors in dairy cattle in Oum El Bouaghi and Khenchela, Northeast Algeria. *Bulg. J. Vet. Med.* (online first).

A cross-sectional study was conducted over three years, from December 2018 to August 2020, to evaluate lameness prevalence and associated risk factors in 1,154 cattle (167 lame, 987 non-lame), across 40 cattle farms in Khenchela and Oum El Bouaghi provinces, Northeastern Algeria. Data were collected on body condition score (BCS), sex, breed, parity, stage of lactation, farm size, production system, hygiene conditions, bedding quantity, flooring type, ventilation, and feed type. The overall lameness prevalence was 14.5%, with significant regional variation: 19.4% (97/500) in Oum El Bouaghi and 10.7% (70/654) in Khenchela (P<0.001). Almost all cattle with lameness lesions had a single lesion (92.8%). Predominant claw lesions included diffuse sole haemorrhage (19.8%), heel horn erosion (18%), digital dermatitis (12.6%), and interdigital phlegmon (8.4%). Hind-limb involvement was predominant (88%), with most pathologies (97% localised to the distal limb). Animal-specific risk factors included breed (Prim'Holstein: 71.3%), body condition score (lean cows: 55.1%), parity (multiparous cows in third lactation: 39%), and lactation stage (mid-lactation: 53.7%). Farm management and environmental risk factors comprised production system (intensive: 82.6%), inadequate hygiene protocols (43.7%), concrete flooring (94.6%), and high-concentrate rations (78.4%). In univariate logistic regression analysis, significant risk factors included poor body condition (BCS<2.5: OR=2.6, 95% CI: 1.4–5.0, P<0.001), Holstein breed (OR=5.1, 95% CI: 2.7–9.6, P<0.001), poor hygiene conditions (OR=2.8, 95% CI: 1.8–4.5, P<0.001), and small farm size (OR=1.5, 95% CI: 1.1–2.1, P=0.023). Female cattle showed significantly higher odds of lameness (OR=5.9, 95% CI: 1.8–18.8, P=0.003). Management practices emphasised curative corrective trimming (58.7%) over preventive interventions, with limited utilisation of systemic and topical medications. These findings elucidate the multifactorial etiology of bovine lameness in the region and underscore the need for comprehensive prevention strategies that target improved husbandry practices, balanced nutrition, and early intervention protocols.

Key words: cattle, claw lesions, lameness, Northeast Algeria, risk factors

INTRODUCTION

Lameness, defined as an abnormal gait resulting from injury, disease, or dysfunction affecting one or more limbs or feet (EFSA AHAW Panel, 2023), represents the third most prevalent health issue in dairy herds globally, following reproductive disorders and mastitis (Charfeddine & Pérez-Cabal, 2017). This condition significantly impacts animal welfare, productivity, and economic sustainability (Dolecheck & Bewley, 2018), and remains one of the foremost health concerns for both producers and veterinarians (Bauman *et al*., 2016).

Lameness induces pain and suffering, thereby compromising the overall welfare of dairy cattle (Shearer *et al*., 2017). The economic burden is substantial, with estimated global annual losses approaching US$6 billion (Rasmussen *et al*., 2024). These losses stem from reduced milk yield, impaired reproductive performance, premature culling, and increased treatment costs (Sadiq *et al*., 2017a). Additional economic impacts arise from milk disposal due to antibiotic administration (Dolecheck & Bewley, 2018; Puerto *et al*., 2021), recurrent lameness cases (Dolecheck & Bewley, 2018), and implementation of preventive measures (Willshire & Bell, 2009).

Lameness encompasses any condition affecting bovine feet or legs of either infectious or non-infectious origin that compromises mobility, posture, and gait (Garvey, 2022; EFSA AHAW Panel, 2023). In dairy cattle, approximately 90% of lameness cases stem from claw lesions, which develop through complex interactions between environmental, management, and animal-specific risk factors (Van Amstel & Shearer, 2006). These lesions include non-infectious conditions (white line disease, sole ulcer, sole hemorrhage, and interdigital hyperplasia) and infectious disorders (digital dermatitis, interdigital dermatitis, heel erosion, and interdigital phlegmon), each presenting distinct diagnostic and management challenges (Van Nuffel *et al*., 2015).

Clinical infectious lameness manifests through pain, reduced mobility, swelling, fever (absent in digital dermatitis cases), decreased milk production, anorexia and weight loss. In subclinical cases, while overt lameness may not be apparent, milk production can still decline (Langova *et al*., 2020). Lame animals typically exhibit increased recumbency, elevating their susceptibility to decubitus and udder disorders, including mastitis (Ózsvári, 2017).

Multiple interconnected risk factors contribute to claw lesion development and subsequent lameness (Greenough, 2007). Key determinants include farm management practices, nutritional regimens, housing conditions (hygiene, flooring), animal characteristics (genetics, breed, parity, lactation stage), and various breeding technologies (Greenough, 2007; Langova *et al*., 2020).

A comprehensive review of 53 international studies revealed lameness prevalence ranging from 5% to 45% across populations, while within-herd prevalence varied from 0% to 88% (Thomsen *et al*., 2023). In Algeria specifically, a participatory epidemiological study conducted by Foughali *et al*. (2021) in Beni Hamidéne locality, province of Constantine, found that 9.6% of 73 cattle owners identified lameness as a prevalent disease and significant source of economic loss in their herds.

Despite the well-established multifactorial nature of lameness, interventions frequently emphasise corrective trimming of severely affected animals while neglecting preventative measures and early treatment strategies that could substantially reduce both incidence and severity (Roche *et al*., 2024; Urban-Chmiel *et al*., 2024). The complex interplay of housing, nutrition, and breed factors necessitates investigation of region-specific risk profiles.

In dairy production systems, particularly those operating in challenging environmental conditions such as the semi-arid climate of Northeast Algeria, understanding lameness prevalence and associated risk factors is essential for developing targeted intervention strategies. This study aims to estimate lameness prevalence and identify risk factors in cattle herds across Khenchela and Oum El Bouaghi (OEB) provinces in Northeast Algeria.

MATERIALS AND METHODS

Study area

A cross-sectional study was conducted between early December 2018 and late August 2020 on 40 cattle farms housing 1,154 cattle in two northeastern Algerian provinces: Oum El Bouaghi (35.783°N, 7.167°E) and Khenchela (35.433°N, 7.133°E ; Fig. 1).

Oum El Bouaghi covers 6,187.56 km² at an altitude of 800 m. The province experiences a continental climate characterised by cold, rainy winters and hot, dry summers, with mean annual precipitation ranging from 350 to 500 mm. The cattle population was estimated at 30,806 head, including 12,874 pure exotic breeds, managed by 594 breeders, who are responsible for the welfare, health, and reproduction of the animals, ensuring their proper care and development, with an average farm size of 51.8 head per farm (DSA OEB, 2024).

Khenchela, situated in the Aurès mountains, encompasses 9,715.6 km². This region has a semi-arid climate with mean annual precipitation between 270 and 400 mm. The provincial cattle population comprises approximately 12,084 animals, including 6,875 dairy cattle, with an average farm size of 37.6 head per farm (DSA Khenchela, 2024).

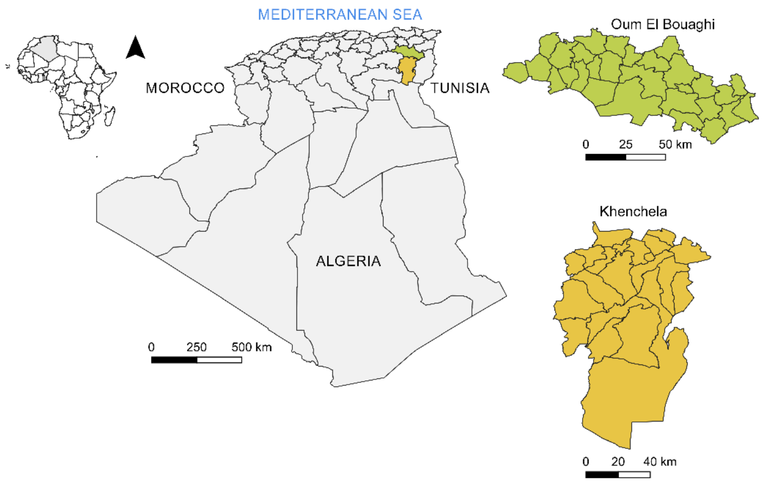

Fig. 1. Geographical location of Khenchela and Oum El Boughi, Northeast Algeria.

Studied farms and animals

The present study was conducted on 40 cattle farms, equally distributed between Oum El Bouaghi (20/40; 50%) and Khenchela (20/40; 50%). The majority of these farms were dairy farms (34/40; 85%), while the remaining ones (6/40; 15%) were mixed farms.

Farm characteristics. All farms (n=40) included in this study contained at least one animal with clinical signs of lameness. Farm characteristics considered were herd size (small farms generally <10 cattle are characterised by family management and limited resources, while large farms >10 cattle require professional management and significant investments), production system (intensive cattle farming is characterised by high animal density, indoor housing systems, and feeding based mainly on cultivated forages and concentrate feeds; extensive cattle farming is defined by low animal density per hectare and relies primarily on natural resources such as pasture and water; semi-intensive systems combine elements of both intensive and extensive systems, often involving partial confinement and mixed feeding strategies), housing type (free stall or tie stall), flooring type (concrete, rubber mats, or slatted), hygiene practices (cleaning frequency, bedding material, and quantity), and ventilation system (static, dynamic, or mixed).

Animal characteristics. All cattle (n=1,154) present on the farms underwent clinical examination for lameness. Of these, 654 (56.7 %) were from Khenchela and 500 (43.3 %) from Oum El Bouaghi.

Lameness status was assessed using standardised locomotion scoring, with cattle classified as lame (n=167) or non-lame (n=987). Only cattle with clinical signs of lameness (167/1,154; 14.5%) were included in this study. The affected animals were all pure exotic breeds (n=167) and belonged to three breed categories: Prim'Holstein (119/167; 71.3%), Montbéliard (37/167; 22.1%), and other breeds including Limousine, Brune des Alpes, Normande, and Tarentaise (11/167; 6.6%).

For each animal, breed, parity (1st, 2nd, 3rd lactation or greater), body condition score (BCS) using a categorical scale (score 1: <2.5, score 2: 2.5–3.5, score 3: >3.5), (Edmonson *et al.,* 1989), and lactation stage (early: 100 first days, mid: 101–200 days, or late: > 200 days) were recorded.

Lameness assessment

Lameness evaluation included recording hind limb conformation (posterior view) using the CASDAR Health Approach (Engel, 2009), categorised as: normal (score 0), slight rotation of feet (score 1), or cow-hocked (score 2). Locomotion score and back posture were assessed using the Sprecher *et al.* (1997) scale: normal (score 1), mildly lame (score 2), moderately lame (score 3), or lame (score 4). All cattle with lameness scores from 1 to 4 were included in this study. Leg cleanliness was evaluated according to Cook (2002): clean (score 1), moderately dirty (score 2), dirty (score 3), or very dirty (score 4).

Lameness was further classified by anatomical location (upper or lower limb) and specific claw lesions were documented. All lesions were categorised according to ICAR and Zinpro guidelines (Kofler *et al.*, 2020; Zinpro, 2021), including sole abscess, white line disease, digital dermatitis, interdigital dermatitis, and other pathologies.

Management practices

This study examined cattle foot care protocols on each farm, including trimming frequency and techniques employed, as well as local and/or systemic treatment regimens for lameness.

Data analysis

Univariate analysis was performed using Pearson's chi-square test. Variables with P<0.05 in univariate analysis were entered into a binary logistic regression model to calculate odds ratios and 95% confidence intervals. Statistical significance was set at P<0.05. All analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA).

Ethical approval

This study was conducted by certified veterinarians who adhered to the ethical recommendations of Algerian regulations concerning the handling and treatment of domestic animals, particularly Law 08-88 of January 26th, 1988, and in compliance with international animal welfare standards, including the Terrestrial Animal Health Code 2018, Section 7, Article 7.5.1, and Algeria's Executive Decree No. 95-363 of November 11th, 1995.

RESULTS

Lameness prevalence and lesion frequency

Among the 40 farms included in this study, a total of 1,154 cattle were examined. The majority were female (91.4%, n=1,055), Holstein breed (50.4%, n=582), and housed on large farms (65.3%, n=753). The overall lameness prevalence was 14.5±1% (167/1,154). Lameness prevalence was significantly higher in Oum El Bouaghi (19.4%; 97/500) compared to Khenchela (10.7%; 70/654; P<0.001).

In this study, 92.8% (155/167) of affected cattle exhibited a single lesion. The most prevalent single claw lesion was diffuse sole haemorrhage (19.8%; 33/167), followed by heel horn erosion (18%; 30/167), digital dermatitis (Mortellaro's disease 12.6%; 21/167), interdigital phlegmon (8.4%; 14/167), and concave dorsal wall (6.5%; 11/167). Multiple lesions were observed in only 7.2% (12/167) of affected cattle (Table 1).

Fig. 2 presents the pattern of foot lesions associated with confirmed and observed lameness cases identified in our study.

Lameness evaluation and lesion distribution

In this study, hind-limb lameness predominated (88%; 147/167) compared to fore-limb involvement (10.8%; 18/167), with mixed limb affection in only 1.2% (2/167) of cases. Lesions were predominantly localised to the distal limb (97%; 162/167), with hock involvement in only 3% (5/167) of cases. The distribution of lameness was nearly equal between the right (52.7%; 88/167) and left limbs (47.3%; 79/167; Table 2).

Animal-related risk factors

Among the 167 cattle with clinical signs of lameness, 71.3% (119/167) were Prim'Holstein, followed by Montbéliard (37/167; 22.1%). Holstein cattle had 5.1 times higher odds of lameness compared to other breeds (OR=5.1, 95% CI: 2.7–9.6, P<0.001). Montbéliard cattle also showed increased risk (OR=2.4, 95% CI: 1.2–4.8, P=0.014). The majority of lame cattle (92/167; 55.1%) had a body condition score (BCS) of 1, using a categorical scale. Cattle with poor body condition (BCS<2.5) had 2.6 times higher odds of lameness compared to cattle with fat body condition (BCS>3.5) (OR=2.6, 95% CI:

Table 1. Frequency of claw lesions observed

Lesion types	Claw lesions	Number of claw lesion cases / Number of cattle affected by lameness	Frequency (%)
Single lesions	Sole hemorrhage diffused form	33/167	19.8
	Heel horn erosion (HE)	30/167	18.0
	Digital dermatitis	21/167	12.6
	Interdigital phlegmon (foot rot)	14/167	8.4
	Concave dorsal wall	11/167	6.5
	Sole abscess	7/167	4.2
	Interdigital hyperplasia	7/167	4.2
	Sole ulcer	7/167	4.2
	Toe necrosis	6/167	3.5
	Double sole	3/167	1.8
	White line disease	3/167	1.8
	Sole hemorrhage circumscribed form	2/167	1.2
	Arthritis	2/167	1.2
	Interdigital dermatitis	2/167	1.2
	White line abscess	1/167	0.6
	Wall abscess	1/167	0.6
	Thin sole	1/167	0.6
	Fracture	1/167	0.6
	Corkscrew claws	1/167	0.6
	Horn fissure horizontal	1/167	0.6
	Horn fissure vertical	1/167	0.6
	Total number of single lesion cases identified in cattle with lameness	155/167	92.8
Multiple lesions	Sole abscess + digital dermatitis	3/167	1.8
	Sole hemorrhage circumscribed form + interdigital phlegmon	3/167	1.8
	Interdigital phlegmon + concave dorsal wall	2/167	1.2
	Thin sole + white line fissure	1/167	0.6
	Interdigital hyperplasia + sole haemorrhage diffused form	1/167	0.6
	Interdigital hyperplasia + digital dermatitis	1/167	0.6
	Digital dermatitis + horn fissure vertical	1/167	0.6
	Total of multiple lesions cases identified in cattle with lameness	12/167	7.2
Total		167/167	100.0

Fig. 2. A: Corkscrew claws; B and D: Interdigital phlegmon; C: Toe ulcer; E: Sole ulcer; F: Bulb ulcer; G and H: Interdigital hyperplasia; I: Digital dermatitis; J: Toe necrosis.

1.4–5.0, P<0.001). Most of lame cattle (164/ 167; 98.2%) were female. They had 5.9 times higher odds of lameness compared to male cattle (OR=5.9, 95% CI: 1.8–18.8, P=0.003; Tables 3 and 4).

Lameness frequency also varied by lactation number: cows in their third lactation (64/164; 39%) showed the highest susceptibility, followed by those in their second (47/164; 28.7%), first lactation (38/164; 23.2%), and fourth lactations (15/164; 9.1%). However, statistical analysis revealed no significant effect of parity on lameness occurrence (P=0.9). Lameness was most prevalent during mid-lactation (88/164; 53.7%), followed by early lactation (63/164; 38.4%). Late lactation showed the lowest occurrence (13/164; 7.9%; Tables 3 and 4). However, stage of lactation had no significant impact on lameness development (P=0.17).

Farm management and environmental risk factors

In this study, the frequency of lameness was higher in larger cattle farms (96/167; 57.5%) compared to smaller farms (71/167; 42.5%). However, smaller cattle farms had significantly higher odds of lameness compared to larger cattle farms (OR=1.5, 95% CI: 1.1–2.1, P=0.023). The intensive production system was associated with the highest lameness frequency (138/167; 82.6%), followed by the extensive system (22/167; 13.2%) and the semi-intensive system (7/167; 4.2%). Both extensive (OR=2.5, 95% CI: 1.1–6.2, P=0.03) and intensive production systems (OR=2.9, 95% CI: 1.4–6.5, P=0.007) had significantly higher odds of lameness compared to semi-intensive systems.

Almost half of the lameness cases (73/167; 43.7%) occurred on farms with poor hygiene scores. However, 38.9% (65/167) were observed on farms rated as "passable" and 17.4% (29/167) on farms with good hygiene ratings. Poor hygiene increased lameness odds by 2.8 times compared to good hygiene conditions (OR=2.8, 95% CI: 1.8–4.5, P<0.001), while passable hygiene also significantly increased the risk (OR=1.7, 95% CI: 1.1–2.6, P=0.034). Most lameness cases (128/167; 76.6%) were observed on farms with abundant bedding, which enhanced lameness odds by 3.9 times compared to little bedding (OR=3.9, 95% CI: 2.4–6.4, P<0.001). Concrete flooring was strongly associated with lameness, with 94.6% (158/167) of cases occurring on this surface type (OR=2.1, 95% CI: 1.1–4.3, P=0.032). Additionally, almost all cattle affected by lameness (166/167; 99.4%) were maintained in static ventilation systems (OR=36, 95% CI: 5–258.9, P<0.001; Tables 3 and 4).

Nutritional risk factors

The majority of lame cattle consumed alfalfa hay and straw (131/167; 78.4%), while the remainder received only straw (36/167; 21.6%). High energy concentrate increased lameness odds by 2.1 times compared to single-type concentrate (OR=2.1, 95% CI: 1.4–3.1, P<0.001).

High-energy, low-fibre complete feeds, particularly those containing wheat flour, were associated with higher lameness frequency (131/167; 78.4%), whereas

Table 2. Evaluation of lameness cases

Lameness evaluation	Modalities of evaluation	Number of cases/ Number of cattle affected by lameness	Frequency (%)
Leg hygiene score (cleanliness)	Score 1 (clean)	1/167	0.6
	Score 2 (moderately dirty)	54/167	32.3
	Score 3 (dirty)	71/167	42.5
	Score 4 (very dirty)	41/167	24.6
Hock posture score (posterior view)	Score 0 (normal)	1/167	0.6
	Score 1 (slight rotation of feet)	87/167	52.1
	Score 2 (cow-hocked)	79/167	47.3
Locomotion score	Score 1 (normal)	2/167	1.2
	Score 2 (mildly lame)	53/167	31.7
	Score 3 (moderately lame)	71/167	42.5
	Score 4 (lame)	41/167	24.6

Table 3. Univariate analysis for potential risk factors associated with lameness

Variable	Category	Number of cases/ number of cattle affected by lameness (frequency %)	Number of examined animals	Lame n (%)	Non-lame n (%)	χ^2	*P* value
Body condition score	Score 1 (< 2.5)	92/167 (55.1)	425	92 (21.7)	333 (78.3)	28.075	< 0.001*
	Score 2 (2.5-3.5)	63/167 (37.7)	602	63 (10.5)	539 (89.5)		
	Score 3 (> 3.5)	12/167 (7.2)	127	12 (9.4)	115 (90.6)		
Sex	Male	3/167 (1.8)	99	3 (3.1)	96 (96.9)	11.453	< 0.001*
	Female	164/167 (98.2)	1055	164 (15.5)	891 (84.5)		
Breed	Others	11/167 (6.6)	229	11 (4.8)	218 (95.2)	37.844	< 0.001*
	Holstein	119/167 (71.3)	582	119 (20.4)	463 (79.6)		
	Montbéliard	37/167 (22.1)	343	37 (10.8)	306 (89.2)		
Parity	1st lactation	38/164 (23.2)	233	38 (16.3)	195 (83.7)	0.269	0.965
	2nd lactation	47/164 (28.7)	295	47 (15.9)	248 (84.1)		
	3rd lactation	64/164 (39)	429	64 (14.9)	365 (85.1)		
	>3 lactation	15/164 (9.1)	98	15 (15.3)	83 (84.7)		
Stage of lactation	Early lactation	63/164 (38.4)	345	63 (18.3)	282 (81.7)	3.454	0.177
	Mid-lactation	88/164 (53.7)	600	88 (14.6)	512 (85.4)		
	Late lactation	13/164 (7.9)	110	13 (11.8)	97 (88.2)		
Farm size	Small farms	71/167 (42.5)	401	71 (17.7)	330 (82.3)	5.194	0.023*
	Large farms	96/167 (57.5)	753	96 (12.8)	657 (87.2)		

Abbreviations: n, number; χ^2, chi-square statistic; *variables selected and used in logistic regression analysis (P<0.05). Note: Parity and stage of lactation analyses were calculated only for female cattle (164 lame cows out of 1,055 total female cattle), excluding male bovines from these specific parameters.

Table 3 (cont'd). Univariate analysis for potential risk factors associated with lameness

Variable	Category	Number of cases/ number of cattle affected by lameness (frequency %)	Number of examined animals	Lame n (%)	Non-lame n (%)	χ^2	*P* value
Production system	Semi-intensive	7/167 (4.2)	118	7 (5.9)	111 (94.1)	8.136	0.017*
	Extensive	22/167 (13.2)	159	22 (13.8)	137 (86.2)		
	Intensive	138/167 (82.6)	877	138 (15.7)	739 (84.3)		
Hygiene	Good	29/167 (17.4)	333	29 (8.7)	304 (91.3)	22.086	< 0.001*
	Passable	65/167 (38.9)	478	65 (13.6)	413 (86.4)		
	Poor	73/167 (43.7)	343	73 (21.3)	270 (78.7)		
Bedding quantity	Abundant	128/167 (76.6)	598	128 (21.4)	470 (78.6)	48.398	< 0.001*
	Average	18/167 (10.8)	231	18 (7.8)	213 (92.2)		
	Little	21/167 (12.6)	325	21 (6.5)	304 (93.5)		
Flooring	Others	9/167 (5.4)	117	9 (7.7)	108 (92.3)	4.834	0.028*
	Concrete	158/167 (94.6)	1037	158 (15.2)	879 (84.8)		
Ventilation type	Static	166/167 (99.4)	977	166 (17)	811 (83)	32.666	< 0.001*
	Dynamic	1/167 (0.6)	177	1 (0.6)	176 (99.4)		
Feed type	High-energy concentrate	131/167 (78.4)	760	131 (17.3)	629 (82.7)	13.754	< 0.001*
	One type concentrate	36/167 (21.6)	394	36 (9.1)	358 (90.9)		

Abbreviations: n, number; χ^2, chi-square statistic; *variables selected and used in logistic regression analysis (P<0.05). Note: Parity and stage of lactation analyses were calculated only for female cattle (164 lame cows out of 1,055 total female cattle), excluding male bovines from these specific parameters.

Table 4. Logistic regression analysis for potential risk factors associated with lameness

Variable	Category	OR	95% CI	P-value	Wald χ^2
Body condition score	Score 1 (< 2.5)	2.648	1.399-5.010	< 0.001	26.976
	Score 2 (2.5-3.5)	1.120	0.585-2.144	0.003	8.952
	Score 3 (> 3.5)		Reference		
Sex	Male		Reference		
	Female	5.890	1.844-18.810	0.003	8.959
Breed	Others		Reference		
	Holstein	5.094	2.690-9.644	< 0.001	24.989
	Montbéliard	2.396	1.196-4.802	0.014	6.072
Farm size	Small farms	1.472	1.054-2.056	0.023	5.153
	Large farms		Reference		
Production system	Semi-intensive		Reference		
	Extensive	2.546	1.049-6.180	0.039	4.270
	Intensive	2.961	1.350-6.493	0.007	7.344
Hygiene	Good		Reference		
	Passable	1.650	1.039-2.619	0.034	4.510
	Poor	2.834	1.789-4.491	< 0.001	19.670
Bedding quantity	Abundant	3.942	2.431-6.393	< 0.001	30.927
	Average	1.223	0.636-2.351	0.545	0.366
	Little		Reference		
Flooring	Others		Reference		
	Concrete	2.157	1.070-4.347	0.032	4.622
Ventilation type	Static	36.025	5.011-258.995	< 0.001	12.682
	Dynamic		Reference		
Feed type	High-energy concentrate	2.071	1.401-3.062	< 0.001	13.321
	One type concentrate		Reference		

Abbreviations: OR, odds ratio; CI, confidence interval.

wheat bran-based feeds appeared to confer reduced risk (36/167; 21.6%; Table 3).

Therapeutic management of lameness

Treatment approaches for lameness varied, with corrective claw trimming being the most frequent intervention (98/167; 58.7%), followed by functional trimming (37/167; 22.1%). Therapeutic interventions included parenteral medication combining antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) – 63/167; 37.7% and local treatments such as copper sulfate with beech tar bandages – 47/167; 28.1% (Table 5).

DISCUSSION

This cross-sectional study estimated the prevalence of lameness and its associated risk factors in 1,154 cattle (167 lame and 987 non lame) across 40 farms in Oum El Bouaghi and Khenchela, Northeastern Algeria. The prevalence of lameness 14.5% was lower than findings reported in Canada (21%; Solano *et al*., 2015; Jewell *et al*., 2019), Bengaluru, India (22.8%; Patoliya *et al*., 2024) and in the south of Eastern Slovakia (25.8%; Hisira *et al*., 2025) and various regions of Algeria, including Constantine (41% of mild lame-

Table 5. Lameness management approaches

Lameness treatment	Modalities of treatment	Number of cases/ Number of cattle affected by lameness	Frequency (%)
Claw trimming	Corrective (therapeutic)	98/167	58.7
	Functional (preventive)	37/167	22.1
	None	32/167	19.2
Parenteral medication	None	85/167	50.9
	Antibiotic + NSAIDs	63/167	37.7
	NSAIDs	12/167	7.2
	Antibiotic	7/167	4.2
Local medication	None	72/167	43.1
	Copper sulfate + beech tar bandage	47/167	28.1
	Formalin + potassium permanganate	28/167	16.8
	Beech tar	12/167	7.2
	Potassium permanganate	8/167	4.8

NSAIDs: non-steroidal anti-inflammatory drugs.

ness in free-stall housing; Djaalab *et al.*, 2021) and Souk Ahras (25%; Kechroud *et al.*, 2023). Our findings align with those from Ethiopian dairy systems (14.1%; Sheferaw *et al.*, 2021), while exceeding rates reported in Ethiopia (10.2%; Gessese *et al.*, 2024) and Ireland (7.9-9.1%; Browne *et al.*, 2022).

The variability in lameness prevalence across different regions can be attributed to multiple factors, including management systems, herd size variations, seasonal fluctuations, breed characteristics, productivity levels, and observational methodology (Van Nuffel *et al.*, 2015; Sheferaw *et al.*, 2021).

Claw lesion analysis revealed high frequencies of diffuse sole haemorrhage (19.8%), heel horn erosion (18%), digital dermatitis (12.6%), and interdigital phlegmon (8.4%). The predominance of mechanical lesions (sole haemorrhage and heel erosion) suggests stress-related disorders, resulting from inadequate flooring conditions, prolonged standing on concrete, or suboptimal hoof trimming practices. Conversely, digital dermatitis and interdigital phlegmon represent infectious conditions caused by specific pathogens, particularly *Treponema* species for digital dermatitis and *Fusobacterium necrophorum* for interdigital phlegmon (Van Amstel & Shearer, 2006). These rates differ from Canadian findings where digital dermatitis occurred at 14.1%, and sole haemorrhage at only 3.2% (Van Huyssteen *et al.*, 2020), highlighting the importance of comprehensive management strategies. Regular preventive hoof trimming, particularly biannual interventions during mid-lactation, can reduce lameness incidence by up to 25% (Urban-Chmiel *et al.*, 2024). Our data revealed a marked predominance of hind-limb lameness (88% versus 10.8% for fore-limb involvement), corroborating Dandani-Chadi *et al.* (2020), who reported 76% of lameness lesions affecting hind-limbs and 24% for front-limbs. This distribution pattern aligns with biomechanical principles, as dairy cattle's hind-limbs bear greater weight and experience increased mechanical stress during locomotion and milk production (Shearer *et al*., 2017). Our findings significantly exceed the 15.3% hind-limb lameness rate reported by Jewell *et al*. (2019), potentially due to differences in assessment methodologies and housing systems.

Breed susceptibility analysis demonstrated significantly higher lameness frequency in Prim'Holstein cattle (71.33%, P<0.001) compared to other breeds, consistent with Dendani-Chadi *et al*. (2020). This greater susceptibility likely stems from the elevated metabolic demands and physiological stress associated with high milk yield, a phenomenon substantiated by Newsome *et al*. (2017). The genetic selection for milk production in Holstein cattle may inadvertently compromise structural integrity and biomechanical efficiency of the locomotor system (Heringstad *et al*., 2018).

Hygiene assessment revealed high lameness frequency (42.5%) in cattle with dirty legs (score 3), slightly lower than findings from Bouira, Northern Central Algeria, but higher than reports from Bédjaïa and Tizi Ouzou regions (Dorbane *et al*., 2022). Elevated leg soiling indicates suboptimal husbandry conditions and compromised environments, primarily associated with infrequent bedding replacement (Jewell *et al*., 2019), with studies demonstrating a significant negative correlation between locomotion and leg cleanliness scores (Bowell *et al*., 2003). Prolonged standing in compromised environments increases mechanical stress from ground contact, may contributing to lameness development. The high frequency of dirty claws (99.4%, combining scores 2, 3, and 4) suggests a strong correlation between poor hygiene and lameness (Table 2). Posture and locomotion assessments revealed significant abnormalities, with 99.4% of animals displaying postural irregularities and 98.8% exhibiting gait disturbances. These findings underscore the importance of comprehensive lameness evaluation that integrates both static (posture) and dynamic (locomotion) assessments for accurate diagnosis and characterisation of lameness severity.

Body condition analysis showed that 55.1% of lame cattle exhibited lean body condition (BCS of 1), indicating poor nutritional status (OR=2.6, 95% CI: 1.4–5.1, P<0.001). This aligns with findings by Solano *et al*. (2015) and Jewell *et al*. (2019), demonstrating frequent lameness occurrence in cows with lower body condition scores. This association may result from lameness-induced reduction in feed intake, as mobility impairment limits access to feeding areas, consequently leading to insufficient body reserves, and establishing a potential link between locomotor disorders and compromised nutritional status. However, we acknowledge that poor nutritional status may also predispose cattle to lameness by compromising claw horn quality and structural integrity, creating increased susceptibility to mechanical damage and infectious conditions. Without longitudinal data, we cannot definitively establish the temporal sequence or determine whether poor body condition is primarily a cause or consequence of lameness in our study population.

Given the predominance of hind-limb lameness, dairy producers should prioritise improvements in flooring and bedding practices to mitigate these conditions.

Although the frequency of lameness appeared to increase with higher parity, in our study, statistical analysis revealed no significant effect of parity on lameness occurrence (P=0.9). This contrasts with multiple studies that have consistently demonstrated increased lameness risk with advancing parity and declining body condition (Solano *et al*., 2015; Jewell *et al*., 2019; Dendani-Chadi *et al*., 2020; Sheferaw *et al*., 2021). Bran *et al*. (2018) specifically noted that cows with more than three parities exhibit greater likelihood of developing new or chronic lameness, attributed to cumulative effects of metabolic stress from repeated lactations. Advanced age increases lameness risk through prolonged exposure to environmental stressors and age-related degeneration of locomotor structures, including joints, ligaments, bones, and digital cushions (Foditsch *et al*., 2016).

While lameness distribution varied across lactation stage in our study, with highest frequency observed during mid-lactation (53.7%), the statistical analysis revealed no significant effect of lactation stage on lameness development (P=0.17). This finding contrasts with prvioius research suggesting that lactation stage significantly influences lameness occurrence, particularly when metabolic demands and physical stress peak during mid-lactation. Oehm *et al*. (2019) identified low body condition (BCS≤2.5 on a 5-point scale), claw overgrowth, early lactation (first 120 days in milk), larger herd size, and higher parity as critical risk factors for lameness, findings subsequently validated by Roche *et al*. (2024) as having the strongest empirical support.

Farm management analysis revealed that intensive production systems (82.6% of cases, P<0.007) significantly increased lameness risk odds by 2.9 times through greater confinement, limited exercise opportunities, and higher stocking densities. Dendani-Chadi *et al*. (2020) documented elevated lameness prevalence in intensive and semi-intensive systems characterised by high milk production targets, silage and grain-based diets, and prolonged indoor confinement (Costa *et al*., 2013). Grazing access has demonstrated protective effects against lameness development (Onyiro *et al*., 2008). Larger farms exhibited higher lameness frequency (57.5%), likely reflecting challenges in maintaining consistent herd management and hygiene protocols across larger animal populations.

Hygiene assessment showed significant correlation between poor facility cleanliness and lameness frequency, highlighting the critical importance of maintaining clean, dry environments to prevent infectious claw lesions. Accumulated excreta in lying areas and passageways creates favorable conditions for pathogen proliferation and claw tissue maceration (Sadiq *et al*., 2017b; Oehm *et al*., 2022).

Counterintuitively, high lameness frequency occurred on farms with abundant bedding (76.6%), likely reflecting inappropriate bedding management rather than quantity. This seemingly counterintuitive finding warrants further investigation, as adequate bedding is generally considered beneficial for claw health.

Inadequate bedding replacement and poor drainage can result in damp, contaminated substrate that promotes bacterial growth and claw lesions (Solano *et al*., 2015). Roche *et al*. (2024) identified deep bedding with organic material or sand, rubber flooring in alleyways, and pasture access as consistently associated with lower lameness levels, while mats or mattresses in lying areas correlated with increased lameness risk.

Flooring analysis revealed that concrete surfaces, present in 94.6% of lameness cases, represent a significant risk factor due to their abrasive properties and inadequate cushioning. Patoliya *et al*.

(2024) demonstrated that concrete floor characteristics hardness, abrasiveness, and slipperiness directly contribute to foot lesions and lameness development. While durable and easily sanitised, concrete provides limited cushioning and can induce traumatic claw lesions, particularly when wet, irregularly scraped, or poorly maintained.

Ventilation assessment revealed predominance of static systems (99.4% of cases), potentially compromising air quality and increasing humidity, creating conditions conducive to pathogen proliferation and claw lesion development. Poor ventilation can also induce heat stress, which reduces immunity in cows and further predisposes them to lameness (Urban-Chmiel *et al*., 2024). These findings align with Doidge *et al*. (2024), who reported that farmers encountered significant challenges with air quality in livestock housing, necessitating interventions such as mechanical ventilation installation and barn redesign to optimise atmospheric conditions.

Nutritional analysis demonstrated that high-energy, low-fibre diets predominantly used in the study regions (78.4% of cases) significantly increase the risk through of ruminal acidosis. This metabolic disorder ($\text{pH}<5.0$) triggers endotoxin release and histamine production, leading to digital vasoconstriction and compromised hoof perfusion, ultimately resulting in laminitis-associated lameness (Blowey, 2015). These findings are supported by recent studies substantiate that excessive consumption of energy-dense, fibre-deficient diets correlates with increased incidence of hoof lesions and locomotor disorders (Bäßler *et al*., 2021), as such diets trigger cascading pathophysiological changes that compromise hoof structural integrity and biomechanical function (Ding *et al*., 2020).

Therapeutic interventions predominantly featured corrective claw trimming (58.7% of cases), involving strategic removal of compromised horn tissue to create aerobic environments and optimise weight distribution. Dandani-Chadi *et al*. (2020) demonstrated significant correlation between trimming frequency and lameness prevalence, with farms implementing less frequent trimming experiencing higher lameness rates (35.4%) compared to those with regular protocols (16.4%). Longitudinal research consistently demonstrates that systematic claw trimming significantly contributes to digital health optimisation (Sadiq *et al*., 2017b). Medical interventions included parenteral medication combining antibiotics and NSAIDs (37.7% of cases) and local treatments such as copper sulfate with beech tar bandages (28.1% of cases). Although copper-containing preparations, oxytetracycline, lincomycin, and topical tetracycline improve digital dermatitis resolution (Cutler *et al*., 2013), Ariza *et al*. (2017) highlighted significant limitations in current evidence regarding treatment efficacy. Additionally, therapeutic approaches frequently involve strategic hoof block application on the healthy claw during trimming, effectively alleviating pressure from claw horn disruption lesions (Roche *et al*., 2024). Combinatorial approaches integrating therapeutic trimming, hoof block application, and NSAID administration have demonstrated promising clinical outcomes (Garcia-Muñoz *et al*., 2017). The predominance of therapeutic over preventive measures suggests a curative rather than proactive approach to lameness management in the study population.

This study underscores that bovine lameness emerges from interconnected relationships between animal characteristics and environmental conditions rather than isolated causes. While breed selection and body condition represent relatively static variables, farms with suboptimal hygiene can significantly mitigate lameness risk through targeted interventions. Strategic improvements in bedding materials and maintaining optimal environmental conditions can substantially reduce the incidence of infectious digital disorders and improve cattle welfare and productivity. Therefore, successful lameness prevention requires coordinated improvements across breeding decisions, housing design, nutritional programmes, and daily management routines, as addressing single factors in isolation proves insufficient for effective control.

This study, based on lameness detection across 40 farms in two provinces of Eastern Algeria, presents several limitations. First, the lack of data on milk production parameters, such as average daily milk yield and peak lactation timing did not allow evaluating potential associations between these variables and the prevalence of lameness. Second, the clinical assessment of lameness symptoms, based on visual observation, is inherently subjective and may be influenced by variations in observer experience and expertise. Finally, since the study was limited to two provinces in Eastern Algeria, the findings may not be fully generalisable to the entire country.

CONCLUSIONS

This study estimated the prevalence of lameness and identified risk factors in cattle in two provinces in Northeast Algeria: Oum El Bouaghi and Khenchela. Our results showed a higher prevalence of lameness in Oum El Bouaghi compared to Khenchela. Lameness predominantly affected the hind limbs, with most affected cattle being of the Prim'Holstein breed. Furthermore, the study found that lameness was more frequent among cattle fed high-energy, low-fibre complete feeds. The identified risk factors offer several intervention opportunities: improved hygiene, optimised bedding management, installation of claw-friendly flooring, enhanced ventilation, and balanced nutritional regimens. Regular preventive claw trimming and early detection of lameness through systematic monitoring through locomotion scoring represent essential management practices that can significantly reduce its incidence and severity. When combined with proper training of farm personnel in early lameness recognition, these preventive measures form an essential part of a comprehensive herd health programmes. Shifting from a curative approach to preventive strategies, including regular functional claw trimming and systematic foot bathing, would improve herd health and economic outcomes. Future research should establish causal relationships between risk factors and lameness development, evaluate intervention effectiveness, and quantify economic impact on regional dairy operations. Implementing preventive programmes tailored to Northeast Algerian farm conditions would significantly enhance animal welfare, productivity, and profitability in this essential agricultural region.

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