

Dairy cattle lameness prevalence, causes and risk factors in selected farms of southern Ethiopia

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Abstract

A cross-sectional study was conducted from October 2018 to December 2019 to estimate the prevalence of lameness in dairy cows, to assess the causes and associated risk factors in southern Ethiopia. A total of 2009 dairy cows were visually and clinically examined, and the overall prevalence of lameness was found to be 14.1% (95% CI=12.7-15.7). The prevalence of lameness was significantly ($P < 0.05$) higher in Arsi Negelle, Yirgalem, and Wolaita Sodo than in Wondo Genet and Hawassa. The prevalence of lameness was also associated with the stages of pregnancy and parity ($P < 0.05$). Generally, the prevalence of lameness in dairy cows was increasing with the increase in parity and stage of pregnancy. The main abnormalities observed in this study were hooves overgrowth (6%), lesions between hooves (4%), lesions on legs (2.2%), trauma (0.6%), arthritis (0.5%), and a sole ulcer (0.3%). Most of these abnormalities were mainly due to faulty management. Hence, based on this finding it is recommended that hoof management and trimming are very essential components of lameness control. Furthermore, early detection and treatment of lame cows; training of the owners on hoof management; and improvement of the housing are helpful to keep lameness at a lower level.

Keywords: Dairy cows; Lameness; Risk factors; Southern Ethiopia.

Introduction

Various authors defined lameness differently; however, the sounder definition is "an abnormal gait that is commonly caused by pain" (Whay and Shrear, 2017). It is the most important condition that influences the productivity, health, and welfare of dairy cows. It has a negative effect on milk production (Specher *et al.*, 1997, Green *et al.*, 2002; Hernandez *et al.*, 2002; Bicalho *et al.*, 2007; Keyserlingk *et al.*, 2009; Huxley, 2013; Mandel *et al.*, 2018). Moreover, economic impact of lameness can be attributed to the cost of treatment and controls (Hernandez and Shearer, 2000), increased calving interval, and impaired reproductive performance (Hernandez *et al.*, 2001) and likely increase the risk of culling (Juarez *et al.*, 2003; Cramer *et al.*, 2009; Huxel, 2013). In addition to the economic impact, lameness also affects the behavioral expression of cows due to pain. Indeed, now a day lameness is one of the most important welfare issues in dairy cattle production (Galindo and Broom, 2002; Tremetsberger and Winckler, 2015).

The causes of lameness in dairy cows are often complex and multifactorial (Bell, 2015; Ranjbar *et al.*, 2016), but are generally recognized as poor quality floors in cattle housing, poor cow tracks, and cows being forced to stand for a too long time on hard surfaces, ineffective foot trimming, infectious diseases and poor nutrition.

In Ethiopia, there is a scarcity of information about the prevalence of lameness in dairy cows and the associated risk factors. Therefore, this study aimed to estimate the prevalence, identify the causes of lameness, and assess the potential risk factors involved in the occurrence of lameness in selected dairy farms in southern Ethiopia.

Materials and methods

Study area

The study was conducted between October 2018 and March 2019 in Hawassa, Wondo Genet, Yirgalem, Arsi Negelle, and Wolaita Sodo towns (Figure 1). Hawassa, Arsi-Negelle, Yirgalem, Wondo-Genet, and Wolaita Sodo are located at 7°3'43.4"N and 38°28'34.9"E, 7°2'59.9"N and 38°41'6"E, 6°45'N and 38°25'E, 7°5'3"N and 38°37'8"E, and 6°51'36"E and 37°45'41.7", respectively. The study areas were located at the escarpment of the rift valley, and they are with good

dairy production potential. The altitudinal range of the study areas is from 1650 (at Hawassa) to 2500 (at Wolaita Sodo and Wondo Genet) meters above sea level (m.a.s.l). The range of annual rainfall was 900–1700 mm for Hawassa, 500–1100 mm for Arsi Negelle, 1314mm for Yirgalem, 1372mm for Wondo Genet, and 1446 mm Wolaita Sodo. The minimum and maximum temperature of Hawassa, Arsi-Negelle, Yirgalem, Wondo-Genet, and Wolaita Sodo were 13°C and 25°C, 12.6°C and 27.3°C, 14°C and 29°C, 9.9°C and 29.5°C, and 15°C and 28°C, respectively (NMA, 2019).

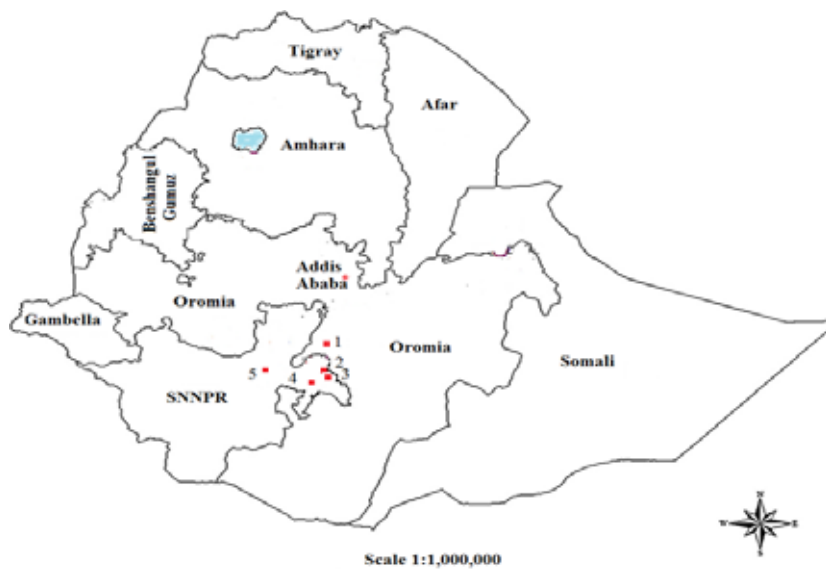


Figure 1. Map of Ethiopia with the regional states and showing the five study areas (1=Arsi Negelle, 2=Wondo Genet, 3=Hawassa, 4=Yirgalem, and 5=Wolaita Sodo)

Study animals and sample size

Information on dairy cows' lameness was collected from 157 small-scale dairy farms selected from the aforementioned five towns in southern Ethiopia. Farms were purposively selected based on the herd size of 5 or more cows. Based on this criterion, the total number of farms selected was 157. All dairy cows and heifers, at breeding age, found in the selected farms were included in the study. This constituted a total of 2,009 cows and heifers. The number of farms and animals selected from each town was shown in Table 1.

Table 1. Number of dairy farms and number of cows sampled for the study

Name of town	Number of farms selected	Number of animals selected
Hawassa	35	789
Yirgalem	34	280
Wondo Genet	43	360
Arsi Negelle	24	168
Wolaita Sodo	21	412
Total	157	2,009

Study design and methodology

A cross-sectional study was employed to assess the prevalence of dairy cows' lameness. All the animals in the selected farms were carefully observed and clinically examined for lameness. During the visit, the study animals were allowed to move and observed for any symptom of abnormal gait as described by Shearer *et al.* (2012) and visual locomotion. Those cows with apparent abnormal gait were clinically palpated for reaction and/or pain, observed for the presence of any lesions, shifting of weight on the limbs, and ticks. Potential risk factors for lameness such as herd size, parity, milking status, stage of pregnancy, hoof overgrowth, and study areas were recorded to assess their association with the disease.

Visual locomotion scoring

All cows in the selected farms were assessed visually for lameness and the gait was scored using a 1- 5 point rating system, where 1=normal, 2=mild lame, 3=moderately lame, 4=lame, and 5=severely lame (Flower and Weary, 2006; Chapinal *et al.*, 2009). The observed lameness was characterized as described by Sprecher *et al.* (1997), Thomsen *et al.* (2008), and Shearer *et al.* (2012). According to Sprecher *et al.* (1997) the definition and classification of cow lameness:

- Normal: Cow stands and walks with a level-back posture, the gait is normal.
- Mild lame: Cow stands with a level-back posture but develops an arched-back posture while walking; the gait remains normal.
- Moderately lame: Arched-back posture is evident, both while standing and walking. Cow's gait is affected and is best described as short striding with one or more limbs.

- **Lame:** Arched-back posture is always evident and gait is best described as one deliberate step at a time.
- **Severely lame:** Cow demonstrates an inability or extreme reluctance to bear weight on one or more of the limbs/feet.

Data analysis

All collected data were entered into Microsoft Excel Spread Sheet, edited and coded, and then, summarized using descriptive statistics like mean. Then, it was analyzed by univariable and multivariable logistic regression analysis to check the association of the aforementioned potential risk factors with the occurrence of lameness. The existences of collinearity among the variable were checked using gamma values (Dohoo *et al.*, 2009). All the statistical analyses were performed on STATA software version 14.2 (STATA Corp, 4905 Lakeway Drive, College Station, Texas 77845 USA). The study considered a 95% confidence level and 5% of absolute desired precision.

Results

Prevalence of clinical lameness

From a total of 2,009 dairy cows and heifers examined 284 (14.1%) animals were found clinically positive for various degrees of lameness. The prevalence of lameness in each of the study towns is shown in Table 2.

Table 2. Dairy cattle lameness prevalence in the study areas

Study area	No examined	No positive (%)	Std. Er.	95% CI
Wondo Genet	360	35 (9.7%)	0.016	7.1-13.2
Hawassa	789	92 (11.7%)	0.011	9.6-14.1
Arsi Negelle	168	28 (16.7%)	0.029	11.7-23.1
Yirgalem	280	50 (17.9%)	0.023	13.8-22.8
Wolaita Sodo	412	79 (19.2%)	0.019	15.7-23.3
Overall	2009	284 (14.1%)	0.008	12.7-15.7

Lameness score

The locomotion of all the study animals' was recorded during the observation period. All dairy cows and heifers with locomotion scores 2 to 5 were found to

be lame. Among the animals observed to have lameness (284), 54.6% (n = 155), 32.7% (n = 93), 12% (n = 34) and 0.7% (n = 2) were mildly, moderately, lame and severely lame, respectively (Table 3).

Table 3. Proportion of locomotion score of dairy cows (N=2009)

Locomotion score	Description	No examined	Proportion (%)
1	Normal (Not lame)	1,725	85.9
2	Mildly lame	155	7.7
3	Moderately lame	93	4.6
4	Lame	34	1.7
5	Severely lame	2	0.1
Total		2009	100

Risk factors of lameness

The result of univariable logistic regression analysis of the prevalence of dairy cows' lameness with various risk factors has been shown in Table 4. Except for the herd size ($P > 0.25$), all the variables considered in the study, that means: study area, parity, milking status, and stage of pregnancy were found significant ($P < 0.05$). All those independent variables, which were significant in the initial univariable analysis checked for co-linearity using Kruskal gamma statistics, and those variables whose gamma value ranged between -0.6 and $+0.6$ were considered in a multivariable logistic regression model. Accordingly, milking status was excluded from multivariable analysis due to collinearity with parity (gamma=0.8665). Thus, the variables included in the multivariable model were study area, parity, and pregnancy stage, and all of these variables were found significant ($P < 0.05$) (Table 5). The Hosmer-Lemeshow goodness-of-fit test suggested that the model fit the data ($\chi^2 = 10.96$; $P = 0.1405$; ROC = 72.1%).

Table 4. Univariable logistic regression analysis of risk factors for the occurrence of lameness

Risk factors	Level of factors	No examined	No positive (%)	Std. Err.	Z	P-value
Study areas	Wondo Genet	360	35 (9.7%)	0.016	-	
	Hawassa	789	92 (11.7%)	0.011	0.97	0.332
	Arsi Negelle	168	28 (16.7%)	0.029	2.27	0.023
	Yirgalem	280	50 (17.9%)	0.023	2.97	0.003
	Wolaita Sodo	412	79 (19.2%)	0.019	3.67	0.000
Parity	* None	960	56 (5.8)	-	-	
	* 1-3	870	182 (20.9)	0.014	9.02	0.000
	* ≥ 4	179	46 (25.7)	0.033	7.83	0.000
Milking	No	1149	67 (5.8)	-	-	
	Yes	860	217 (25.2)	0.015	11.43	0.000
Pregnancy stage	None	1543	189 (12.2)	-	-	-
	1st trimester	276	46 (16.7)	0.022	2.01	0.045
	2nd trimester	105	27 (25.7)*	0.043	3.84	0.000
	3rd trimester	85	22 (25.9)*	0.048	3.53	0.000
Herd size	≤ 9	563	75 (13.3)	0.014		
	10 to 49	925	132 (14.3)	0.012	0.51	0.608
	≥ 50	521	77 (14.8)	0.016	0.69	0.490

Table 5. Multivariable logistic regression analysis of potential risk factors for lameness in dairy cattle, southern Ethiopia.

Risk factors	No examined	No positive (%)	OR	95% CI	P-value
Areas					
Wondo Genet	360	35 (9.7%)	-	-	
Hawassa	789	92 (11.7%)	2.71	1.19-2.29	0.007
Arsi Negelle	168	28 (16.7%)	1.98	1.01-3.01	0.048
Yirgalem	280	50 (17.9%)	3.27	1.40-3.88	0.001
Wolaita Sodo	412	79 (19.2%)	5.37	2.24-5.65	<0.001
Parity					
Heifers	960	56 (5.8)	-	-	
1-3	870	182 (20.9)	4.06	2.92-5.64	<0.001
≥ 4	179	46 (25.7)	6.11	3.80-9.82	<0.001
Pregnancy stage					
None	1543	189 (12.2)	-	-	
1 st trimester	276	46 (16.7)	1.34	0.92-1.96	0.046
2 nd trimester	105	27 (25.7)*	2.65	1.60-4.41	<0.001
3 rd trimester	85	22 (25.9)*	2.59	1.49-4.51	<0.001

Abnormalities observed

During the study period, about eleven different types of abnormalities presumed to be the causes of lameness were observed. Clinically hoof overgrowth was the most commonly identified abnormality followed by lesion between hooves and on the legs (Table 6).

Table 6. Causes of lameness encountered during the study and their proportion

Abnormalities	Frequency	Proportion (%)
Hoof overgrowth	120	42.3
Lesions between hooves	80	28.2
Lesions on legs	44	15.5
Sole ulcer	6	3.3
Arthritis (Carpal and tarsal joint swelling)	10	5.5
Abscess on leg	2	1.1
Trauma and/or bruising on leg	13	7.2
Swelling on leg	4	2.2
Interdigital ticks infestation	9	3.2
Fracture of leg	6	2.1
Faulty injection	4	2.2
Two and more than two abnormalities	14	4.9

Discussion

The prevalence of lameness in dairy cows recorded in the present study, 14.1%, is comparable to the report from various parts of the world (Gitau *et al.*, 1996; Haskell *et al.*, 2006; Somers *et al.*, 2015; Abunna *et al.*, 2017). However, it is lower than the reports from countries like the UK (Rutherford *et al.*, 2009; Barker *et al.*, 2010; Leach *et al.*, 2010), Czech Republic (Šárová *et al.*, 2011), Turkey (Yaylak *et al.*, 2010), Canada and USA (Von Keyserlingk *et al.*, 2012). In contrast, it is relatively higher than the reports from Sweden (Manske *et al.*, 2002), New Zealand (Fabian *et al.* 2014), Denmark (Alban, 1995), the USA (Wells *et al.*, 1993), and Ethiopia (Sulayeman and Fromsa, 2012). The variation in the prevalence of lameness between the different areas might be due to the differences in the management system, herd size, seasonal variation, breeds, level of productivity of the cows, and observer's subjectivity (Winckler and Willen, 2001; Channon *et al.*, 2009; Huxley *et al.*, 2012; Van Nuffel *et al.*, 2015; Moreira *et al.*, 2018). A dairy cow managed predominantly indoors will typically experience excessive net hoof growth because growth exceeds wear (Bell *et al.*, 2009). Hoof overgrowth is one of the major causes of lameness as also observed during this study. It was noted that all cows with hoof overgrowth had lameness (Table 6). During the study period, the locomotion of all the cows was observed and scored as described by Sprecher *et al.* (1997) and Flower and Weary (2006) and the result was shown in Table 3. During this

study comparatively higher proportion of mild (7.7%) than moderate (4.6%) lameness was observed.

In the multivariable logistic regression analysis, the prevalence of lameness was significantly ($P < 0.05$) associated with the study area, parity, and stage of pregnancy. The odds of lameness in dairy cattle in Hawassa (OR = 2.71), Arsi Negelle (OR = 1.98), Yirgalem (OR = 3.27), and Wolaita Sodo (OR = 5.37) was significantly higher than in Wondo-Genet. During this study, the smallest and highest prevalence was recorded at Wondo Genet and Wolaita Sodo, respectively. These differences might be due to the variation in the management of cows between the two study areas. As observed during the study period in most of the dairy farms in Wolaita Sodo animals were managed indoor, while in Wondo-Genet animals had a certain period for outdoor exercises. The same holds true, i.e. indoor management, for Yirgalem and Arsi-Negelle. It was well documented that animals kept on pasture had a lower prevalence of lameness (Haaskell *et al.*, 2006; Olmos *et al.*, 2009; Adams *et al.*, 2017).

In the present study, the prevalence of lameness in dairy cows increased with an increasing parity number. This is also in agreement with several previous reports around the world (Groehn *et al.*, 1992; Wells *et al.*, 1993; Radostits, 2001; Mohamadnia *et al.*, 2008; Olmos *et al.*, 2009; Yaylak *et al.*, 2010; Solano *et al.*, 2015; Foditsch *et al.*, 2016; Daros *et al.*, 2019). It was noted that the likelihood of lameness was 6.1 and 4.1 times higher in cows with 4 or more parities and in their first to third parity compared to heifers, respectively. According to Solano *et al.* (2016), the problem of sole ulcer and white line diseases is increasing with parity and perhaps this may be responsible for the higher prevalence of lameness in multiparous cows.

The prevalence of lameness in dairy cows was significantly associated ($P < 0.05$) with the stages of pregnancy. The odds of lameness was significantly higher in pregnant than non-pregnant cows, and there was an increase in the prevalence of lameness with the advancement of pregnancy. The OR was 1.5, 2.7, and 3.6 times more in first, second and third pregnancy than non-pregnant, respectively. This is mainly due to the changes in hoof loading with pregnancy, which may predispose the cows' to lameness (Scott, 1988 ; Chapinal *et al.*, 2008).

In the present study, hoof overgrowth (6.2%) was the major cause of lameness followed by lesions between hooves (4%), lesions on legs (2.2%), trauma, and/or bruising (0.6%), and arthritis (0.5%). These abnormalities are reported to be

the cause for cattle lameness by other authors (Radostits, 2001; Huxley *et al.*, 2012; Sulayeman and Fromsa, 2012; Bell, 2015). All cows found lame in this study had overgrown hooves (n=120, 6%). The association of hoof overgrowth with lameness had also been reported by different authors (Sulayeman and Fromsa, 2012; Solano *et al.*, 2015; Sadiq *et al.*, 2017; Oehm *et al.*, 2019). The sole ulcer is a common report as a cause of lameness in dairy cows (Murray *et al.*, 1996; Radostits, 2001; Barker *et al.*, 2007; Huxley *et al.*, 2012; Sulayeman and Fromsa, 2012; Bicalho and Oikonomou, 2013; Bell, 2015).

Conclusions

The overall prevalence of dairy cows' lameness in the southern part of Ethiopia was 14.1%. This study revealed that lameness in dairy cows is associated with increasing parity, stage of pregnancy, and management difference among the study sites. The most commonly observed abnormalities in the study animals were hoof overgrowth, arthritis, sole ulcer, interdigital ticks' infestation, and trauma and/or bruising.

Most of the abnormalities observed were due to faulty management, and hence, hoof management and proper trimming is a very essential component of lameness control. Furthermore, detection and treatment of lame cows and training of the farm owners are helpful to keep the prevalence of lameness at a lower level.

Conflict of interest

The authors declare that there is no conflict of interest

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