The Effects of Geographic Region and Breed on the Prevalence of Foot Diseases in Dairy Cows in Türkiye: A Systematic Review and Meta-Analysis

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Abstract

Foot diseases in dairy cows substantially affect animal welfare and farm profitability. This systematic review and meta-analysis estimated the pooled prevalence of foot diseases in dairy cows in Türkiye and assessed the effects of region, breed, and sample size. A comprehensive literature search was conducted for studies published between January 1999 and September 2024 in accordance with PRISMA guidelines. Eligible studies were analyzed using a random-effects meta-analysis model. Heterogeneity was assessed using Cochran's Q test and the I^2 statistic, and publication bias was evaluated through Egger's test and funnel plot analysis. Of 5,779 studies identified, 31 met the inclusion criteria. The overall pooled prevalence was 20.52% (95% CI: 16.23–25.19). By region, prevalence ranged from 6.76% to 51.59%, with Holsteins showing the highest prevalence among breeds (13.22%). A comparison of study periods revealed that the prevalence significantly increased from 16.93% (95% CI: 12.01–22.50) in 1999–2014 to 24.81% (95% CI: 17.46–32.98) in 2015–2024. These findings highlight regional and breed-related differences in the prevalence of foot diseases in dairy cows in Türkiye.

Keywords: Breed, Cow, Foot disease prevalence, Geographic region, Sample size, Türkiye

Introduction

Foot diseases and lameness in dairy cows are among the health problems that significantly affect animal welfare and rural economies all over the world [1-3], including in Türkiye [4,5]. Among the foot problems frequently encountered in cows, infectious illnesses (e.g., digital dermatitis) [6,7], and noninfectious illnesses (e.g., sole ulcer and white line disease) stand out due to the adverse conditions they create [8-10]. Foot diseases cause severe economic losses linked to early culling, decreased milk yields, and reduced reproductive performance [11-13]. Furthermore, individual treatment costs ranged from USD 51.5 to 1.517 (2019 price levels) depending on the type of lesion [14]. Additionally, a 2024 study reported an average lameness cost of USD 153.8 per case in dairy farms in Türkiye [15]. Therefore, the rapid detection and accurate diagnosis of foot lesions are important in ensuring animal welfare and minimizing economic losses [16].

Milk production and dairy farming are sustainable agricultural activities that contribute significantly to a country's economy [17]. The prevalence of foot diseases, especially in dairy farms, varies based on factors such as geographic region, herd size, and breed; it is also affected by environmental and management conditions. Different climate structures and regional differences in herds contribute to the prevalence of foot diseases [18,19]. For example, cows in humid and temperate regions may be more prone to certain foot diseases due to prolonged exposure to wet conditions, which are conducive to bacterial proliferation [20,21]. Likewise, the risk of infectious disease may increase in larger herds and foot diseases may become more common in herds due to poor management [22]. Studies conducted in different regions of Türkiye show that the prevalence of foot diseases varies from east to west, with rates ranging from 8.1% [23] to 38.77% [21]. Although there are regional studies on the prevalence

and contributing factors of foot diseases in dairy cattle in Türkiye, there is still a lack of comprehensive data. Understanding the factors affecting such diseases is critical in developing prevention strategies for dairy farms and eliminating administrative problems. This study asked the following research question: Do geographic region, breed, and sample size affect the prevalence of foot diseases in cows in Türkiye? It evaluated the prevalence of foot diseases in dairy cattle throughout Türkiye, and it calculated a combined rate. By analyzing the effects of geographic region, breed, and sample size on illness rates, this study advances the relevant literature.

MATERIAL AND METHODS

Research Question

Do geographic region, breed, and sample size affect the prevalence of foot diseases in cows in Türkiye?

Search Strategy and Literature Review

This study is based on the PRISMA statement and the checklist is provided in Supplementary material [24,25]. Between July and September 2024, a keyword-based search was carried out in the databases of PubMed, Web of Science, Google Scholar, Scopus, Dergipark, and the National Thesis Center using the online library platform of Cukurova University. The following search terms were employed: "cow," "foot disease," "prevalence," and "Türkiye." The complete search strategies, including Boolean operators and database-specific search strings, are provided in Supplementary material. After a detailed literature search, all relevant observational studies (e.g., cross-sectional and cohort studies), studies including the prevalence of foot illnesses, master's theses, and doctoral dissertations were considered. The findings were filtered to include only studies published in the past 26 years, from January 1999 to September 2024, in English and Turkish. The resulting studies were classified as included or excluded based on an initial review of their titles and abstracts and whether they answered the abovementioned research question.

Inclusion and Exclusion Criteria

The flow chart for the systematic review and the article selection process for the meta-analysis, which was created based on the PRISMA guidelines, is presented in *Fig. 1*. First, a total of 5.779 studies published between January 1999 and September 2024 were collected through a comprehensive literature search. Then, these studies were selected according to the following inclusion criteria: a) English and Turkish articles published in peer-reviewed journals investigating the prevalence of foot diseases in different regions of Türkiye; b) observational studies (e.g., cross-sectional and cohort studies); c) studies with data on the prevalence or rates of foot diseases in cows;

d) studies specifying the geographic region, breed, and sample size; e) master's theses and doctoral dissertations providing information on the rates or prevalence of foot diseases in cows in Türkiye. The exclusion criteria were as follows: a) master's theses or doctoral dissertations without information on the rates or prevalence of foot diseases, b) studies using only male animals, and c) studies not providing details on the rates or prevalence of foot diseases. In meta-analyses involving more than one geographic region, each region was considered a separate study, and the data were evaluated by region. If more than one breed was investigated in a study, the number of cows with foot diseases was considered separately by breed.

Data Extraction

Two authors independently screened all the full-text studies to determine whether they met the inclusion and exclusion criteria. In the identified studies, only numerical data of the diseases that constitute the rates or prevalence of foot diseases were collected, and the framework of the study was created by not extracting data on the diseases. Using a standard data extraction form, the first author's name, year of publication, breed(s) of cows used in the study, geographic region, sample size, and number of cows with foot diseases were recorded. The list of the studies included in the meta-analysis and their detailed characteristics are given in *Table 1*. The data were classified by dividing them into subgroups based on animal breed (Holstein, Simmental, Brown Swiss, native, and mixed), geographic region (Marmara, Aegean, Mediterranean, Central Anatolia, Southeastern Anatolia, and Eastern Anatolia), sample size (less than 1.000 and more than 1.000), and study year (first 16 years, last 10 years, and 26 years in total). Then, the numbers of cows with foot diseases and the total sample-size values were extracted separately from these subgroups. The Black Sea region, one of the seven regions of Türkiye, was not included in the study because there was not enough information about it. Disagreements between the authors were resolved through discussion.

Data Quality Appraisal

Data quality of all the studies was assessed using 10 quality control items described by Joanna Briggs Institute prevalence critical appraisal [51]. The tool evaluated the following: sample frame, sampling methods, sample size, description of setting, sufficient coverage for data analysis, objective and reliable methods for identifying the condition, appropriate statistical analysis, and adequate response rate. The tool appraises each domain as Yes/No/Unclear/Not applicable. We assigned a value 1 to a Yes answer and a value 0 if the answer was No/Unclear/Not Applicable. A higher score denotes a higher quality study, with a maximum attainable score of 10. As the Joanna Briggs Institute tool does not define a specific cutoff for acceptable quality, a threshold of ≥5 (i.e., at least 50% of the quality domains fulfilled) was used to distinguish studies

Table 1. *Information about 31 studies was included in the meta-analysis on the prevalence of foot diseases in dairy cows*

Study Number	Study	Breed	Geographic Region	Sample Size	Number of Foot Diseases in Cows
1	Sağlıyan et al., 2010 [26]	Undefined	Eastern Anatolia	1352	387
2	Kulualp et al., 2021 [27]	Holstein, Simental	Aegean	1685	179
3	İstek et al., 2019 [18]	Holstein, Simental, Brown Swiss, Native, Mixed	Eastern Anatolia	422	100
4	Erol et al., 2019 [28]	Brown Swiss	Central Anatolia	200	80
5	Ormancı and Belge, 2001 [29]	Holstein, Simental, Brown Swiss, Native, Mixed	Eastern Anatolia	1800	321
6	Tutuş and Gençcelep, 2021 [23]	Simental, Brown Swiss, Native, Mixed	Eastern Anatolia	1686	128
7	Çeçen et al., 2018 [30]	Holstein	Aegean	93	33
8	Şengöz Şirin et al, 2021 [5]	Simental	Mediterranean	281	269
9	Özcan and Pamuk, 2009 [31]	Holstein, Simental, Brown Swiss, Native, Mixed	Central Anatolia	1800	195
10	Atasoy N, 2003 [32]	Holstein, Simental, Brown Swiss, Native, Mixed	Eastern Anatolia	924	210
11	Şındak et al., 2003 [33]	Undefined	Southeast Anatolia	4432	134
12	Yayla et al., 2012 [19]	Simental, Brown Swiss, Native, Mixed	Eastern Anatolia	2317	280
13	Yurdakul and Şen, 2018 [21]	Undefined	Central Anatolia	1302	514
14	Yakan S, 2018 [34]	Undefined	Eastern Anatolia	1255	222
15	Keskin and Durmuş, 2016 [35]	Undefined	Southeast Anatolia	1818	209
16	Saruhan A, 2015 [36]	Holstein, Simental, Native, Mixed	Eastern Anatolia	570	43
17	Canatan U, 2020 [37]	Undefined	Marmara	85	84
18	Daştan İ, 2009 [38]	Holstein, Simental, Brown Swiss, Native, Mixed	Aegean	1090	71
19	Aydınoğlu AG, 2009 [39]	Holstein, Simental, Native, Mixed	Mediterranean	1320	77
20	Yılmaz Tan F, 2020 [40]	Undefined	Eastern Anatolia	1303	14
21	Kavuş MT, 2022 [41]	Undefined	Eastern Anatolia	4000	292
22	Pirci B, 2011 [42]	Holstein	Central Anatolia	100	37
23	Akın İ, 2008 [43]	Holstein	Marmara	540	42
24	Yaylak et al., 2010 [22]	Holstein	Aegean	1080	305
25	İstek ve Durgun, 2004 [44]	Undefined	Eastern Anatolia	1356	184
26	Kayapınar and Han, 2021 [45]	Undefined	Eastern Anatolia	7040	547
27	Canpolat and Bulut, 2003 [46]	Undefined	Eastern Anatolia	3600	512
28	Güzel and Erden, 2000 [47]	Undefined	Aegean	505	233
29	Çeçen and Görgül, 2007 [48]	Holstein	Marmara	547	196
30	Sağlıyan and Ünsaldı, 2002 [49]	Undefined	Eastern Anatolia	1688	144
31	Ayhan HD, 2019 [50]	Undefined	Eastern- Southeast Anatolia	600	465

with moderate methodological quality from those with lower quality. This approach is consistent with previous prevalence meta-analyses using the same appraisal tool [51]. In all stages of this process, discrepancies between reviewers were resolved by consensus.

Statistical Analysis

Before the meta-analysis, publication bias was examined statistically with Egger's test [52] and graphically with the funnel plot in all subgroups. The trim-and-fill method was used to eliminate publication bias. Egger's test was not

used if the number of studies included in the meta-analysis was less than 10. Cochran's Q test evaluated the heterogeneity of the effect sizes of the studies. The Q statistics were calculated with I^2 values. If the heterogeneity was statistically significant, the random effects model was used to estimate the effect size; if the heterogeneity was not significant, the fixed effects model was employed. The effect sizes of individual studies were obtained as a result of the meta-analysis, and the combined effect sizes were shown graphically with forest plots. The heterogeneity of the subgroups was determined based on the animal breeds, geographic regions, sample sizes, and study years of the studies included in each subgroup. Then, the combined rates with 95% CI according to the sample sizes and numbers of cows with foot diseases were calculated. The chosen level of statistical significance was $P < 0.05$, but $\alpha = 0.10$ was taken as indicating publication bias and heterogeneity. MedCalc version 23.0.9. (free trial) was used for the meta-analysis, and the meta and metafor packages of R version 4.4.1. (R Core Team, 2021) were employed to look for publication bias.
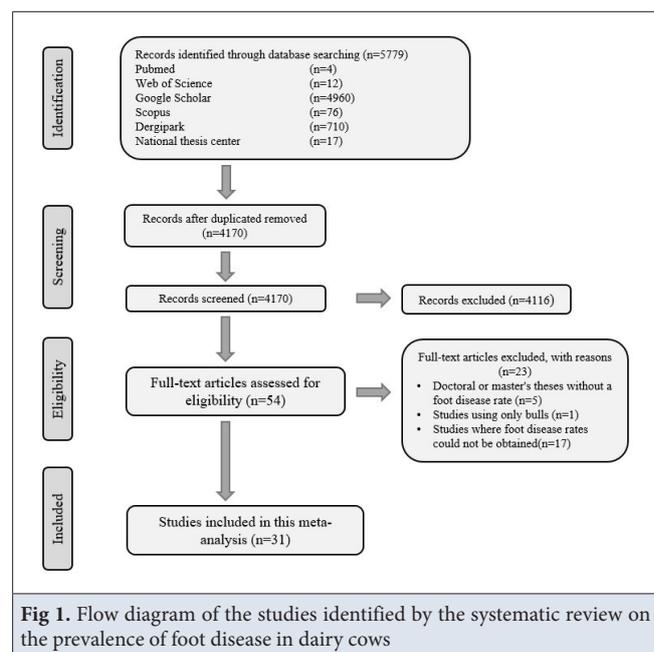
RESULTS

Study Characteristics

A total of 31 articles that met the inclusion criteria were deemed suitable for meta-analysis. The selection process is shown in *Fig. 1*. Meta-analyses were performed on the subgroups based on geographic region, breed, sample size, and publication year. Among the studies, 14 articles did not specify animal breeds were not included in the meta-analysis in the breed subgroup; hence, analyses were performed on 17 articles. The list of the studies included in the meta-analysis and their detailed characteristics are presented in *Table 1*. The most common breed was the Holstein (n=13), followed by the Simmental (n=11); the other three breeds were equally common (n=9). From a geographic perspective, the eastern Anatolia region had the most studies (n=14), while the Mediterranean region had the least (n=2). Also, 11 studies with sample sizes of less than 1,000 were identified, while 20 studies with sample sizes of more than 1.000 were found. Regarding the publication years, 16 studies were published in the first 16 years (1999-2014) and 15 were published in the last 10 years (2015-2024). The quality assessment indicated that most included studies were of acceptable quality. The average score was 7.25 points (range 5-9, with higher scores denoting higher quality articles), where the best scores were associated with sampling, sample frame, methods for sampling, and sample size. A summary of the quality assessment is presented in the Supplementary Material.

Meta-Analysis Results

No evidence of publication bias was detected in the subgroups with more than 10 studies, and the trim-and-fill

Fig 1. Flow diagram of the studies identified by the systematic review on the prevalence of foot disease in dairy cows

method was not used to determine effect sizes. Heterogeneity between the studies was statistically significant in all the subgroups according to Cochran's Q test; hence, the random effects model was used to determine effect sizes.

Breed

The meta-analysis results concerning the breeds are shown in *Table 2*. The effect sizes were calculated by considering heterogeneity. There were heterogeneous distributions in all the breeds. The rate of foot diseases was highest in Holstein cows (13.22%) and lowest in native breed cows (3.88%). The funnel and forest plots for the Holstein breed are presented in *Fig. 2*. The funnel and forest plots for the other breeds can be found in Supplementary Material.

Geographic Region

The meta-analysis findings regarding the geographic regions are shown in *Table 3*. There were heterogeneous distributions in all the regions. The prevalence rates of foot diseases were as follows: 51.59% in the Mediterranean region, 50.02% in Marmara, 30.73% in Central Anatolia, 23.45% in the Aegean, 11.82% in Eastern Anatolia, and 6.76% in Southeastern Anatolia. The funnel and forest plots for the Central Anatolia region are presented in *Fig. 3*. The funnel and forest plots for the other regions can be found in Supplementary Material.

Sample Size

The meta-analysis results concerning the two sample-size groups are shown in *Table 4*. There were heterogeneous distributions in both groups. The pooled prevalence was 41.67% in studies with sample sizes <1.000 and 11.77% in studies with sample sizes >1.000. The relevant funnel and forest plots are given in Supplementary Material.

Publication Year

Table 5 presents the findings of the meta-analysis regarding the studies' publication years. There were heterogeneous distributions in all three groups. In the group concerning the first 16 years (1999-2014), the rate of foot diseases was 16.93%; in the group pertaining to the last 10 years (2015-2024), the rate increased to 24.81%. In the group
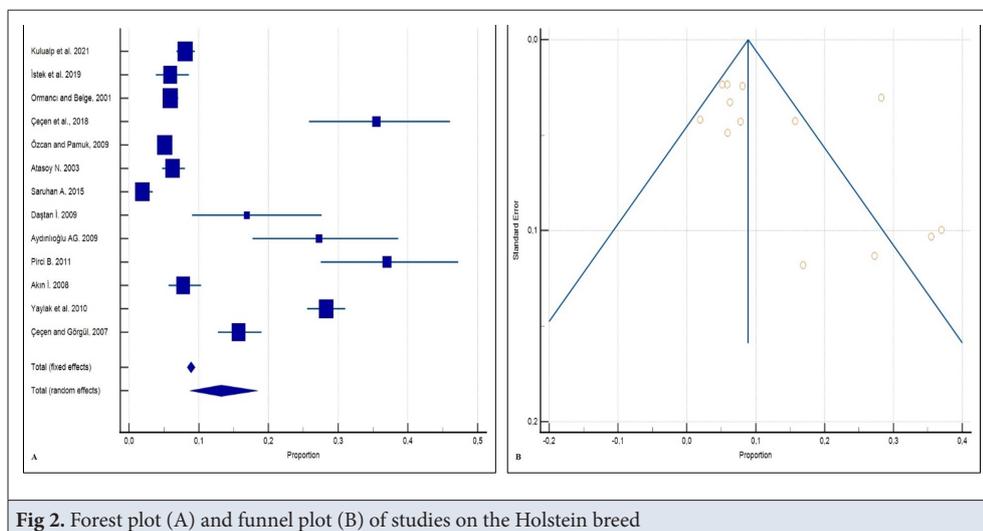

Fig 2. Forest plot (A) and funnel plot (B) of studies on the Holstein breed

Table 2. *Prevalence rates of breed, heterogeneity, and Egger test results*

Breed	Proportion (%)	95% CI	Test for Heterogeneity			Egger Test (P-value)
			Q	*P*-value	I² (%)	
Holstein	13.22	8.75-18.45	566.57	<0.001	97.88	0.163
Simmental	9.37	3.64-17.41	1606.64	<0.001	99.38	0.144
Brown swiss	8.17	4.26-13.21	499.44	<0.001	98.40	-
Native	3.88	2.29-5.86	146.67	<0.001	94.55	-
Mixed	5.16	3.13-7.66	181.82	<0.001	95.60	-

CI: Confidence interval, Q: Cochran Q statistics, I: numerical expression of heterogeneity

Table 3. *Prevalence rates of geographic region, heterogeneity, and Egger test results*

Geographic Region	Proportion (%)	95% CI	Test for Heterogeneity			Egger Test (P-value)
			Q	P-value	I² (%)	
Marmara	50.02	10.54-89.97	443.23	<0.001	99.55	-
Aegean	23.45	10.80-39.17	484.57	<0.001	99.17	-
Mediterranean	51.59	8.20-89.96	1153.71	<0.001	99.91	-
Central Anatolia	30.73	12.67-52.58	399.45	<0.001	99.25	-
Southeast Anatolia	6.76	3.68-10.69	165.03	<0.001	98.18	-
Eastern Anatolia	11.82	7.87-16.43	1979.49	<0.001	99.34	0.446

CI: Confidence interval, Q: Cochran Q statistics, I: numerical expression of heterogeneity

Table 4. *Prevalence rates of sample size, heterogeneity, and Egger test results*

Sample Size	Proportion (%)	95% CI	Test for Heterogeneity			Egger Test (P-value)
			Q	P-value	I² (%)	
<1000	41.67	24.45-60.01	1445.15	<0.001	99.31	0.119
>1000	11.77	8.75-15.17	2293.14	<0.001	99.17	0.258

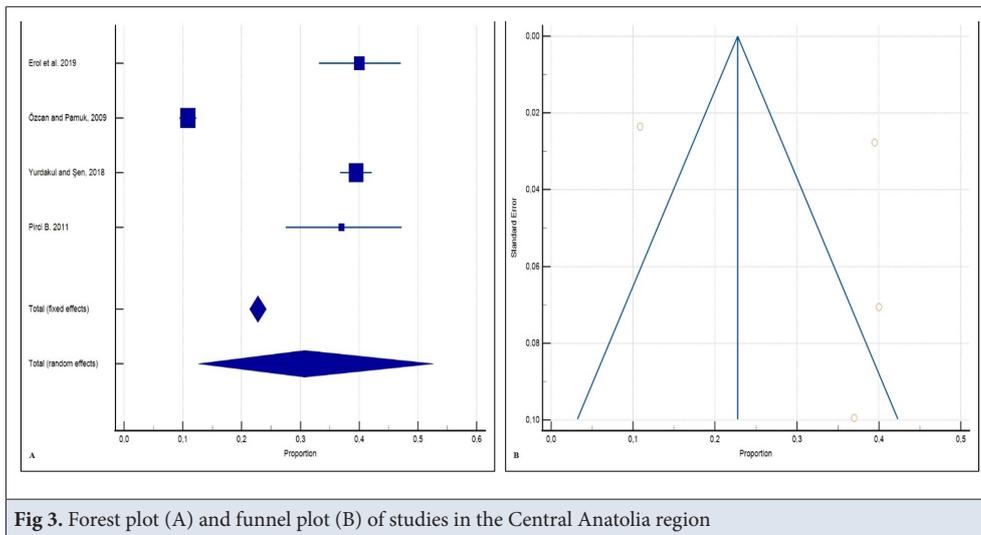*CI: Confidence interval, Q: Cochran Q statistics, I: numerical expression of heterogeneity*

Fig 3. Forest plot (A) and funnel plot (B) of studies in the Central Anatolia region
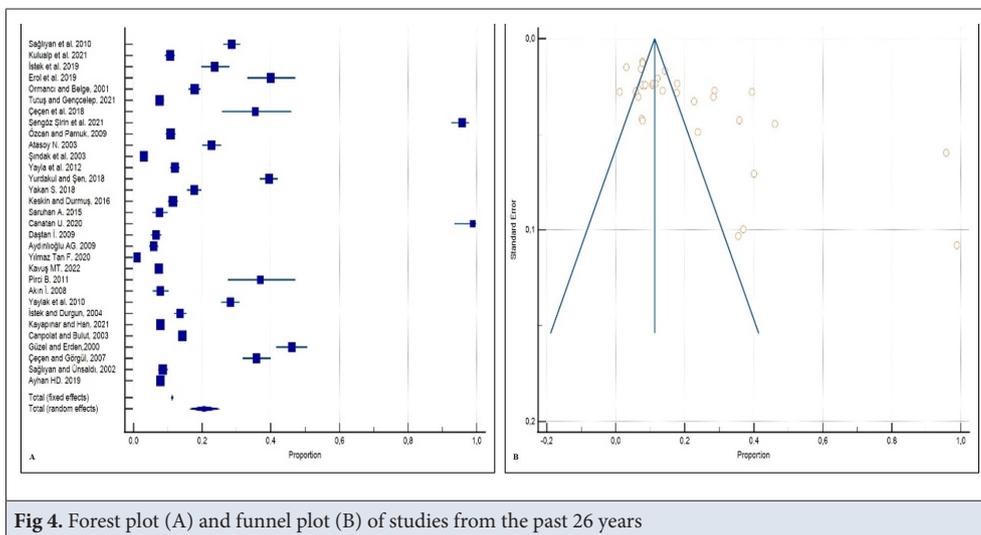

Fig 4. Forest plot (A) and funnel plot (B) of studies from the past 26 years

Table 5. *Meta-analysis results for different year intervals.*

Year	Proportion (%)	95% CI	Test for Heterogeneity			Egger Test (P-value)
			Q	P-value	I² (%)	
First 16 years	16.93	12.01-22.50	1801.69	<0.001	99.17	0.571
Last 10 years	24.81	17.46-32.98	2956.19	<0.001	99.53	0.225
Total 26 years	20.52	16.23-25.19	4809.29	<0.001	99.38	0.378
CI: *Confidence interval,* **Q:** *Cochran Q statistics,* **I:** *numerical expression of heterogeneity*						

regarding the whole period (26 years), the foot disease rate was 20.52%. The funnel and forest plots for the studies in the latter group (whole period) are presented in *Fig. 4*. The funnel and forest plots for the other two groups can be found in Supplementary Material.

Discussion

This study examined the effects of geographic region, breed, and sample size on the prevalence of foot diseases in cows in Türkiye. It calculated a combined rate of foot

disease prevalence from existing data. The prevalence of foot diseases in cows varies depending on the breed and type of disease [35,45]. Among the factors affecting the prevalence of such diseases, herd size, building type, lying space and floor type, grazing period, feeding methods, and the seasonal distribution of lameness are all important. Also, keeping regular lameness records is critical for monitoring animal health and welfare [53]. Furthermore, housing conditions have also been shown to impact prevalence; the rates of foot diseases in free-stall

systems are lower than those in tie-stall systems [54]. The present meta-analysis revealed the effects of geographic region, animal breed, and sample size on prevalence and the differences in prevalence of subgroups.

The data used in systematic reviews and meta-analyses of the prevalence of foot diseases in cows vary. These analyses combine studies conducted in different countries of the world [16] or studies from different regions of the same country [55]. Oehm et al.[56] performed meta-analysis according to the coefficients (odds ratio), standard errors, and risk factors. Afonso et al.[55] carried out meta-analysis based on the lameness incidence rates obtained from their included studies. Dutton-Regester et al.[1] conducted meta-analysis according to the sensitivity and specificity values of their selected studies. In the present meta-analysis, the percentage values of the foot disease prevalence rates were obtained based on the sample sizes and numbers of cows with foot diseases from 31 studies, and proportional meta-analyses of these data were performed. Although some primary studies used the term "incidence," it is important to distinguish between incidence and prevalence as separate epidemiological measures. Incidence refers to newly occurring cases over a defined period, whereas prevalence represents the proportion of existing cases at a given time. In the present meta-analysis, the synthesized estimates correspond to prevalence data.

According to the meta-analysis, the pooled prevalence of foot disease was 20.52% (95% CI: 16.23-25.19). A difference in pooled prevalence was observed between study periods. In the 16 studies covering the first 16 years of the study period, the pooled prevalence was 16.93% (95% CI: 12.01-22.50), whereas in the 15 studies representing the most recent 10 years, the pooled prevalence was 24.81% (95% CI: 17.46-32.98). This apparent increase in pooled prevalence should not be interpreted as a definitive rise in the true frequency of foot diseases. The higher estimates observed in more recent studies may reflect improved detection methods, increased awareness among farmers and veterinarians, changes in reporting practices, or differences in study design and sampling strategies rather than a true epidemiological increase. Compared with other studies in Europe, the foot disease rate on farms in England and Wales was 36.8% [57]. In Greece, the lameness prevalence was 18.7% [58]. In a study that reported the prevalence of lameness in four countries, the rates were as follows: 25% in Germany, 24% in France, 10% in Spain, and 7% in Switzerland [53]. In our meta-analysis, the prevalence of foot diseases in cows varied widely, from 1.07% [40] to 98.82% [37]. The latter figure comes from a study of foot diseases in slaughterhouse material collected in the Bursa region, where the presence of at least one claw lesion in almost all the feet and the scope of the study explain the high rate [37]. Overall, these findings suggest that foot diseases remain a significant health concern in dairy cattle, although prevalence estimates may vary substantially depending on study design, sampling methods, and regional management conditions.

The present meta-analysis demonstrated substantial variation in the prevalence of foot diseases across geographic regions in Türkiye. The Mediterranean region showed the highest pooled prevalence (51.59%, 95% CI: 8.20-89.96), whereas Southeastern Anatolia had the lowest prevalence (6.76%, 95% CI: 3.68-10.69). The Marmara region had the second-highest prevalence (50.02%, 95% CI: 10.05-89.97). These findings suggest notable regional differences in the burden of foot diseases. However, no eligible studies were available for the Black Sea region; therefore, analyses were limited to six regions, which represents an important limitation of this study. Additionally, the high prevalence estimates observed in the Mediterranean and Marmara regions were accompanied by wide confidence intervals, reflecting considerable statistical uncertainty. These estimates were based on a limited number of studies (e.g., n = 2 for the Mediterranean region) and may have been influenced by specific study characteristics. For example, a small-scale study conducted using slaughterhouse material in the Marmara region reported a prevalence of 98.82%, which may have disproportionately affected the pooled estimate. Therefore, these regional estimates should be interpreted with caution. Regional variations in climate, herd size, housing systems, and access to pasture may partly explain the observed differences. Previous research has shown that access to pasture improves foot health, with lower rates of foot diseases and lameness observed in cows that spend more time grazing compared to those kept in confined housing systems [59]. Moreover, elevated summer temperatures and increased heat stress have been associated with a higher risk of foot disorders [60,61]. However, in our meta-analysis, the prevalence of foot diseases in Southeastern Anatolia was the lowest despite the region's high summer average temperatures. By examining the studies conducted in this region in terms of seasonal conditions and increasing the number of studies, different explanations can be made regarding the effect of heat stress on cows.

In 6 of the 17 studies contained in the meta-analysis of animal breeds, a single breed was investigated, while in the other 11 studies, more than one breed was looked at. The most common breed was the Holstein, which was also the breed with the highest rate of foot diseases (13.22%, 95% CI: 8.75-18.45). The fact that Holstein cows dominate the industry due to their productivity and that they become less resistant to foot diseases compared to other breeds when sufficient care is not taken of them has been reported in other studies [31,62]. Foot disease rates among breeds vary according to the region where the study has

been conducted, the study methods (clinical trial, survey, etc.), and the herd's characteristics. While breeds such as Holstein [22,30,42,43], Simmental [5], and Brown Swiss [28] are used in herd-based studies, it is noticeable that the number of breeds is greater than one in prevalence studies addressing specific regions [18,29,31,32,38]. Furthermore, the rate of foot diseases in cattle is increasing, especially as intensive housing conditions have become widespread and breeds such as Holstein and Simmental have adapted to them [32,44]. In addition, changes in the genetic structure of breeds, the physical and environmental conditions to which breeds are exposed, and different care management practices all affect the prevalence of foot diseases [63].

Subgroup analyses further indicated differences in pooled prevalence according to sample size. The pooled prevalence was 11.77% (95% CI: 8.75-15.17) in studies including ≥1.000 animals and 41.67% (95% CI: 24.45-60.01) in studies with <1.000 animals. The narrower confidence interval observed in larger studies suggests greater statistical precision, whereas smaller studies demonstrated greater variability in prevalence estimates [22,64]. For example, a study involving 7.040 animals in the Malatya region reported a prevalence of 7.77% [45], whereas in a single-herd study conducted on 281 cows in the Burdur region reported a prevalence of 95.73% [5]. In our study, the rate of foot diseases was generally high in studies with sample sizes of less than 1.000 [28,42]; it is noteworthy that these studies were mostly conducted in single herds. The studies with sample sizes of more than 1,000 [33,41,46] mainly covered more than one herd; accordingly, the decrease in the rate of foot diseases was noticeable. Therefore, the observed inverse pattern between sample size and pooled prevalence likely reflects differences in study design, representativeness, and statistical precision rather than a true biological association [65].

In addition, a higher pooled prevalence was observed in studies conducted during the most recent decade (24.81%) compared with those from the earlier study period (16.93%). However, this apparent increase should be interpreted cautiously. Rather than representing a definitive rise in the true frequency of foot diseases, the difference may reflect enhanced diagnostic awareness, improved detection methods, and increased reporting practices within the Turkish dairy sector. Furthermore, the substantial methodological heterogeneity observed across studies (I^2 >99%) suggests that variations in sampling strategies, diagnostic criteria, and case definitions between study periods may have significantly influenced the pooled estimates. Without accounting for these methodological differences, a purely biological interpretation of the temporal pattern would be inappropriate. Overall, the observed trend likely reflects improvements in case detection and documentation rather than a straightforward escalation in disease occurrence.

CONCLUSION

Foot diseases remain an important health concern in dairy cattle in Türkiye. The pooled prevalence of 20.52% (95% CI: 16.23-25.19) obtained in this meta-analysis should not be interpreted as the true national population prevalence. Rather, this estimate represents a statistical summary of studies conducted over a 26-year period using different methodological approaches, diagnostic criteria, and sampling strategies, with substantial heterogeneity (I^2 = 99.38%). Therefore, the pooled value should be interpreted cautiously and viewed as an aggregated epidemiological indicator rather than a definitive population parameter. These findings highlight the need for standardized surveillance systems and well-designed, large-scale observational studies to better characterize the current burden of foot diseases in the national dairy herd.

HIGHLIGHT KEYPOINTS

- Geographical region, breed, and sample size are effective in the prevalence of foot diseases.
- The pooled prevalence of foot diseases in Türkiye is 20.52%.
- The Holstein breed showed the highest prevalence among breeds.
- Prevalence significantly increased after 2015.
- Prevalence ranged from 6.76% to 51.59% across geographical regions.

DECLARATIONS

Author Contributions: All authors contributed to the study conception and design. VAC: Conceptualization, Data curation, Investigation, Methodology, Resources, Validation, Writing - original draft, Writing - review and editing, UC: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Visualization, Writing - review and editing, EU: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Writing - review and editing

REFERENCES

1. **Dutton-Regester KT, Barnes TS, Wright JD, Alawneh JI, Rabiee AR:** A systematic review of tests for the detection and diagnosis of foot lesions causing lameness in dairy cows. *Prev Vet Med,* 149, 53-66, 2018. DOI: 10.1016/j.prevetmed.2017.11.003

2. **Kofler J, Berger P, Egger-Danner C, Fuerst-Waltl B:** Benchmarking claw health across three dairy cow breeds in 508 dairy farms using numerical claw health indicators. *Vet J,* 308:106242, 2024. DOI: 10.1016/j.tvjl.2024.106242

3. **Sahar MW, Beaver A, Daros RR, von Keyserlingk MAG, Weary DM:** Measuring lameness prevalence: Effects of case definition and assessment frequency. *J Dairy Sci,* 105 (9): 7728-7737, 2022. DOI: 10.3168/jds.2021-21536

4. **Han MC, Sağlıyan A, Polat E:** Sığırlarda ahır zemin tiplerinin ayak hastalıkları ve tırnak deformasyonları üzerine etkilerinin araştırılması. *Harran Üniv Vet Fak Derg,* 6 (1): 19-24, 2017. DOI: 10.31196/huvfd.325680

5. **Sengöz-Şirin Ö, Önür A, Şavklıyıldız F:** Burdur yöresinde bir sağmal süt sığırı (simental) işletmesinde gözlenen ayak hastalıklarının incelenmesi. *MAE Vet Fak Derg,* 6 (1): 22-27, 2021. DOI: 10.24880/maeuvfd.884378

6. **Fürmann A, Syring C, Becker J, Sarbach A, Weber J, Ruiters MW, Steiner A:** Prevalence of painful lesions of the digits and risk factors associated with digital dermatitis, ulcers and white line disease on swiss cattle farms. *Animals,* 14 (1):153, 2024. DOI: 10.3390/ani14010153

7. **Palmer MA, O'Connell NE:** Digital dermatitis in dairy cows: A review of risk factors and potential sources of between-animal variation in susceptibility. *Animals,* 5 (3): 512-535, 2015. DOI: 10.3390/ani5030369

8. **Alrhmoun M, Gauly M, Poulopoulou I:** Seasonal prevalence and geographical distribution of claw health in dairy cows: Investigation of the causal relationship with breed. *J Dairy Sci,* 108 (1): 980-995, 2025. DOI: 10.3168/jds.2024-25204

9. **Bicalho RC, Oikonomou G:** Control and prevention of lameness associated with claw lesions in dairy cows. *Livest Sci,* 156 (1-3): 96-105, 2013. DOI: 10.1016/j.livsci.2013.06.007

10. **Shearer JK, Plummer PJ, Schleining JA:** Perspectives on the treatment of claw lesions in cattle. *Vet Med (Auckl),* 6, 273-292, 2015. DOI: 10.2147/VMRR.S62071

11. **Booth CJ, Warnick LD, Gröhn YT, Maizon DO, Guard CL, Janssen D:** Effect of lameness on culling in dairy cows. *J Dairy Sci,* 87, 4115-4122, 2004. DOI: 10.3168/jds.S0022-0302(04)73554-7

12. **Kofler J, Suntinger M, Mayerhofer M, Linke K, Maurer L, Hund A, Fiedler A, Duda J, Egger-Danner C:** Benchmarking based on regularly recorded claw health data of austrian dairy cattle for ımplementation in the cattle data network (RDV). *Animals,* 12 (7):808, 2022. DOI: 10.3390/ani12070808

13. **Shearer JK, Hutjens MF, Endres MI:** Managing the herd to minimize lameness. **In,** Beede DK (Ed): Large Dairy Herd Management. 3ʳᵈ ed., 1093-1102, American Dairy Science Association, IL, 2017.

14. **Alvergnas M, Strabel T, Rzewuska K, Ewa Sell-Kubiak E:** Claw disorders in dairy cattle: Effects on production, welfare and farm economics with possible prevention methods. *Livest Sci,* 222, 54-64, 2019. DOI: 10.1016/j.livsci.2019.02.011

15. **Sarıözkan S, Küçükoflaz M:** Total financial and avoidable losses due to lameness in Turkish dairy herds. *Ankara Univ Vet Fak Derg,* 71 (3): 329-334, 2024. DOI: 10.33988/auvfd.1214635

16. **Thomsen PT, Shearer JK, Houe H:** Prevalence of lameness in dairy cows: A literature review. *Vet J,* 295:105975, 2023. DOI: 10.1016/j.tvjl.2023.105975

17. **Ergün OF, Bayram B:** Changes in the livestock sector in Turkey. *J Bahri Dagdas Anim Res,* 10 (2): 158-175, 2021.

18. **İstek Ö, Han MC, Tanrısever M:** Fırat üniversitesi hayvan hastanesine getirilen sığırlardaki tırnak deformasyonları ile ayak hastalıklarının retrospektif değerlendirilmesi. *Harran Üniv Vet Fak Derg,* 8 (1): 57-63, 2019. DOI: 10.31196/huvfd.591121

19. **Yayla S, Aksoy Ö, Kılıç E, Cihan M, Özaydın İ, Ermutlu CŞ:** Kars ve yöresinde sığırların bakım ve barındırma koşulları ile ayak hastalıkları arasındaki ilişkinin değerlendirilmesi. *Harran Üniv Vet Fak Derg,* 1 (1): 22-27, 2012.

20. **İzci C:** Sığırlarda Ayak Hastalıkları ve Topallık Kontrolü. 38-46, Selçuk Üniversitesi Basımevi, Konya, 2018.

21. **Yurdakul İ, Şen İ:** Sivas ve yöresinde sığır ayak hastalıkları prevalansının belirlenmesi. *Harran Üniv Vet Fak Derg,* 7 (1): 51-55, 2018. DOI: 10.31196/huvfd.470735

22. **Yaylak E, Akbaş Y, Kaya IA, Uzmay C:** The effects of several cow and herd level factors on lameness in Holstein cows reared in Izmir province of Turkey. *J Anim Vet Adv,* 9 (21): 2714-2722, 2010. DOI: 10.3923/javaa.2010.2714.2722

23. **Tutuş D, Genççelep M:** Van muradiye ilçesinde ruminantlarda görülen ekstremite ve ayak hastalıklarının insidansı. *Van Vet J,* 32 (2): 82-90, 2021. DOI: 10.36483/vanvetj.957429

24. **Moher D, Liberati A, Tetzlaff J, Altman DG:** Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med,* 6 (7):e1000097, 2009. DOI: 10.1371/journal.pmed.1000097

25. **Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D:** The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ,* 372:n71, 2021. DOI: 10.1136/bmj.n71

26. **Sağlıyan A, Gunay C, Han MC:** Prevalence of lesions associated with subclinical laminitis in dairy cattle. *Israel J Vet Med,* 65 (1): 27-33, 2010.

27. **Kulualp K, Ozturan YA, Akin I:** Assessment of animal and management based potential risk factor relation with claw health and lameness in dairy cows: A cross-sectional study. *Large Anim Rev,* 27, 323-328, 2021.

28. **Erol H, Erol M, Alkan F:** Evaluation of encountered claw lesions in dairy farm (Brown Swiss) in Konya province. *Eurasian J Vet Sci,* 35 (1): 24-28, 2019.

29. **Ormancı S, Belge A:** Van ve yöresinde süt sığırlarında ayak hastalıklarının nedenleri, dağılımı ve sağaltımı üzerine çalışmalar. *YYÜ Sağ Bil Derg,* 7 (1-2): 139-145, 2001.

30. **Ceçen G, İlhan G, Orman A:** Distribution of hoof lesions and hoof health strategies on a robotic milking farm. *Uludag Univ J Fac Vet Med,* 37 (1): 29-36, 2018. DOI: 10.30782/uluvfd.393935

31. **Özcan S, Pamuk K:** Afyonkarahisar ve çevresinde sığır ayak hastalıklarının prevalansı. *Kocatepe Vet J,* 2 (2): 15-19, 2009.

32. **Atasoy N:** Erzurum yöresinde süt sığırlarında görülen ayak hastalıklarının insidansı ve bunların sağaltımı. *YYÜ Vet Fak Derg,* 14 (1): 1-5, 2003.

33. **Şındak N, Keskin O, Selçukbiricik H, Sertkaya H:** Şanlıurfa ve yöresinde sığır ayak hastalıklarının prevalansı. *YYÜ Vet Fak Derg,* 14 (1): 14-18, 2003.

34. **Yakan S:** Ağrı ilinde sığırlarda ayak hastalıkları prevalansının belirlenmesi. *Harran Üniv Vet Fak Derg,* 7 (2): 207-212, 2018. DOI: 10.31196/huvfd.508987

35. **Keskin E, Durmuş AS:** Gaziantep ve yöresinde gözlenen sığır ayak hastalıklarının insidansı ve tedavileri üzerine gözlemler. *FÜ Sağ Bil Vet Derg,* 30 (3): 181-186, 2016.

36. **Saruhan A:** Mardin yöresinde bazı süt sığırcılığı işletmelerinde ayak hastalıklarının prevalansı. *Master's thesis,* Harran University, Institute of Health Sciences, 2015.

37. **Canatan U:** Bursa ilindeki sığırlarda ayak biyomekaniğinin morfolojik, radyolojik, patolojik ve taban yük dağılımı bulguları ile karşılaştırmalı araştırılması: randomize *eks-vivo* çalışma. *PhD thesis,* Bursa Uludag University, Institute of Health Sciences, 2020.

38. **Daştan İ:** Denizli yöresinde süt sığırlarında ayak hastalıklarının insidansı, nedenleri ve sağaltımı. *Master's thesis,* Yüzüncü Yıl University, Institute of Health Sciences, 2009.

39. **Aydınoğlu AG:** Antalya ili il merkezi ve merkez köylerinde sığırların ayak hastalıklarının insidansı. *Master's thesis,* Yüzüncü Yıl University, Institute of Health Sciences, 2009.

40. **Yılmaz Tan F:** Ardahan mezbahasına kesim için getirilen sığırlarda ayak hastalıklarının insidansı, saptanan hastalıklar üzerine radyolojik ve histopatolojik incelemeler. *Master's thesis,* Kafkas University, Institute of Health Sciences, 2020.

41. **Kavuş MT:** Elazığ ve Erzincan yöresi ayak hastalıklarının değerlendirilmesi. *Master's thesis,* Fırat University, Institute of Health Sciences, 2022.

42. **Pirci B:** Kayseri Develi Tarımsal Kalkınma Kooperatifi süt sığırı çiftliğinde bulunan sığır tırnaklarının muayenesi ve problemli tırnakların sağaltımı. *Master's thesis,* Erciyes University, Institute of Health Sciences, 2011.

43. **Akın İ:** Süt sığırlarında bazı tırnak hastalıklarının iyileşme sürecinde kan serumu ve tırnak dokusu iz element düzeyleri ile yeni oluşan tırnak dokusunun histolojik kalitesi arasındaki ilişki. *PhD Thesis,* Uludag University, Institute of Health Sciences, 2008.

44. **İstek Ö, Durgun T:** Muş ve yöresindeki sığırlarda görülen ayak hastalıklarının prevalansı üzerine araştırmalar. *Fırat Üniv Doğu Araş Derg,* 3 (1): 39-47, 2004.

45. **Kayapınar SD, Han MC:** Malatya ve yöresinde sığır ayak hastalıklarının prevalansı. *FÜ Sağ Bil Vet Derg,* 35 (1): 37-42, 2021.

46. **Canpolat İ, Bulut S:** Elazığ ve çevresinde sığırlarda görülen ayak hastalıklarının insidansı üzerine gözlemler. *FÜ Sağlık Bil Dergisi,* 17 (3): 155-160, 2003.

47. **Güzel N, Erden H:** Aydın yöresi sığırcılık işletmelerinde ayak hastalıklarının dağılımı. *Vet Cerrahi Derg,* 6 (3-4): 8-10, 2000.

48. **Çeçen G, Görgül OS:** Bursa yöresindeki bir işletmede, sağmal süt sığırı sürüsünde karşılaşılan topallıkların değerlendirilmesi. *Vet Cerrahi Derg,* 13 (1): 5-10, 2007.

49. **Sağlıyan A, Ünsaldı E:** Tunceli ve yöresindeki sığırlarda karşılaşılan ayak hastalıklarının insidansı üzerine gözlemler. *FÜ Sağlık Bil Dergisi,* 16 (1): 47-56, 2002.

50. **Ayhan HD:** Elazığ ve Adıyaman yöresinde sığırlarda ayak hastalıkları prevalansının araştırılması. *Master's thesis,* Fırat University, Institute of Health Sciences, 2019.

51. **Munn Z, Moola S, Riitano D, Lisy K:** The Development of a critical appraisal tool for use in systematic reviews: Addressing questions of prevalence. *Int J Health Policy Manag,* 3 (3): 123-128, 2014. DOI: 10.15171/ijhpm.2014.71

52. **Egger M, Smith GD, Schneider M, Minder C:** Bias in meta-analysis detected by a simple, graphical test. *BMJ,* 315, 629-634, 1997. DOI: 10.1136/bmj.315.7109.629

53. **Sjöström K, Fall N, Blanco-Penedo I, Duval JE, Krieger M, Emanuelson U:** Lameness prevalence and risk factors in organic dairy herds in four European countries. *Livest Sci,* 208, 44-50, 2018. DOI: 10.1016/j.livsci.2017.12.009

54. **Sogstad AM, Fjeldaas T, Østerås O, Forshell KP:** Prevalence of claw lesions in Norwegian dairy cattle housed in tie stalls and free stalls. *Prev Vet Med,* 70 (3-4): 191-209, 2005. DOI: 10.1016/j.prevetmed.2005.03.005

55. **Afonso JS, Bruce M, Keating P, Raboisson D, Clough H, Oikonomou G, Rushton J:** Profiling detection and classification of lameness methods in british dairy cattle research: A systematic review and meta-analysis. *Front Vet Sci,* 7:542, 2020. DOI: 10.3389/fvets.2020.00542

56. **Oehm AW, Knubben-Schweizer G, Rieger A, Stoll A, Hartnack S:** A systematic review and meta-analyses of risk factors associated with lameness in dairy cows. *BMC Vet Res,* 15:346, 2019. DOI: 10.1186/s12917-019-2095-2

57. **Barker ZE, Leach KA, Whay HR, Bell NJ, Main DCJ:** Assessment of lameness prevalence and associated risk factors in dairy herds in England and Wales. *J Dairy Sci,* 93, 932-941, 2010. DOI: 10.3168/jds.2009-2309

58. **Katsoulos PD, Christodoulopoulos G:** Prevalence of lameness and of associated claw disorders in Greek dairy cattle industry. *Livest Sci,* 122 (2-3): 354-358, 2009. DOI: 10.1016/j.livsci.2008.09.012

59. **Tillack A, Merle R, Müller KE, Hoedemaker M, Jensen KC, Bartel A, Oehm AW, Klawitter M, Stock A:** The relationship between lameness prevalence and pasture access in 659 dairy herds in Germany. *PLoS One,* 19 (6):e0305536, 2024. DOI: 10.1371/journal.pone.0305536

60. **Sanders AH, Shearer JK, De Vries A:** Seasonal incidence of lameness and risk factors associated with thin soles, white line disease, ulcers, and sole punctures in dairy cattle. *J Dairy Sci,* 92 (7): 3165-3174, 2009. DOI: 10.3168/jds.2008-1799

61. **Shearer JK, van Amstel SR, Benzaquen M, Shearer LC:** Effect of season on claw disorders (including thin soles) in a large dairy in the southeastern region of the USA. 14th International Symposium and 6th Conference on Lameness in Ruminants, 8-11 November, 110-111, Colonia, Uruguay, 2006.

62. **Baird LG, O'Connell NE, McCoy MA, Keady TWJ, Kilpatrick DJ:** Effects of breed and production system on lameness parameters in dairy cattle. *J Dairy Sci,* 92, 2174-2182, 2009. DOI: 10.3168/jds.2008-1333

63. **Heringstad B, Egger-Danner C, Charfeddine N, Pryce JE, Stock KF, Kofler J, Sogstad AM, Holzhauer M, Fiedler A, Müller K, Nielsen P, Thomas G, Gengler N, de Jong G, Ødegård C, Malchiodi F, Miglior F, Alsaaod M, Cole JB:** Invited review: Genetics and claw health: Opportunities to enhance claw health by genetic selection. *J Dairy Sci,* 101, 4801-4821, 2018. DOI: 10.3168/jds.2017-13531

64. **Akbulut Ö:** Çok değişkenli ve farklı ölçekli araştırmalarda örneklem büyüklüğünün tespiti. *J Anim Sci Prod (JASP),* 4 (2): 199-215, 2021. DOI: 10.51970/jasp.946399

65. **Chapinal N, Barrientos AK, von Keyserlingk MAG, Galo E, Weary DM:** Herd-level risk factors for lameness in freestall farms in the northeastern United States and California. *J Dairy Sci,* 96 (1): 318-328, 2013. DOI: 10.3168/jds.2012-5940