Laminitis in Cattle: A Bibliometric Analysis

Hakan SERİN[1]* ᴵᴰ Muslu Kazım KÖREZ[2] ᴵᴰ

[1]* Selcuk University, Faculty of Veterinary Medicine, Department of Biostatistics, Konya, Türkiye

[2] Selcuk University, Faculty of Medicine, Department of Biostatistics, Konya, Türkiye

Article Info	ABSTRACT
	Laminitis is a condition characterized by lameness, which poses a significant economic burden on the dairy industry. The condition presents a challenge in combat due to its multifactorial etiology. This is why it remains a widespread issue globally, including the developed countries. This study aims to reveal publication trends and interactions between studies outcomes based on the data obtained from the Web of Science. To access the appropriate articles, a search was conducted using the keyword "laminitis" as the inclusion criteria. The search criteria included selecting "English" as the language, "Article" as the document type, and "All Fields" as the search method. The study revealed that a total of 967 articles were published during the analyzed period. The average annual growth rate of the studies was found to be 6.35%. The highest number of articles were published in 2019 with 64 articles (6.61%). With the keyword analysis, "lameness", "cattle," and "dairy cattle" were identified as the most relevant keywords. The analysis of the keywords indicated that laminitis is an important concern not only for animal welfare but also for behavioral sciences as well as economic loss. In terms of article count, the United Kingdom exhibited the highest performance. The journal with the highest number of articles in this field was Preventive Veterinary Medicine 8.8% (85 articles). Whay H.R. from the United Kingdom was identified as the most influential author. A general upward trend in the number of publications primarily driven by developed countries was observed during the period analyzed in the study.

*Corresponding Author: Hakan Serin, *hakan.461995@gmail.com*

INTRODUCTION

Laminitis, also referred to as diffuse aseptic pododermatitis, is inflammation occurring within the dermal layers of the hoof (Belge et al., 2005; Momcilovic et al., 2000) Numerous factors including age, parturition, lactation, and milk production contribute to the development of laminitis (Orhun et al., 2023). Among them, excessive intake of fast-digesting carbohydrates stands out as a primary factor (Şenyüz and Karslı 2021a, 2021b). As a metabolic consequence of ruminal acidosis, degeneration of the dermo-epidermal junction occurs in the laminar region of the hoof. Many studies have examined the relationship between acidosis and laminitis in cattle (Danscher et al., 2009; Ding et al., 2020). Laminitis in cattle manifests in four distinct forms: acute, subacute, chronic, and subclinical (Altuğ et al., 2019; Bergsten, 1994). Subclinical laminitis is more difficult to detect compared to other forms of laminitis because movement changes are not observed despite physical changes in the hoof (Smilie et al., 1996).

Nowadays, laminitis causes significant economic challenges primarily due to its impact on milk production. Mastitis, reproductive issues, and laminitis stand out as significant contributors to milk production losses. Laminitis can result in weight loss, reduced milk production, disturbances in the reproductive cycle, and ultimately, culling. In addition to these, treatment costs also increase economic loss (Burger, 2017). In a study conducted in the UK, it was reported that laminitis accounted for 27% of the cost attributed to production diseases during the 1992-1993 breeding season (Kossaibati and Esslemont, 1997). Apart from economic losses, laminitis inflicts pain on the animals, which leads to a significant decline in their welfare. Controlling laminitis is challenging because it doesn't exhibit symptoms during the subclinical stage (Bell and Weary, 2000).

Bibliometrics is a statistical method utilized to review a particular field of literature, assess its progression, and identify future trends (Miao et al., 2022). Different research methods need to be used together to provide a holistic understanding of any given topic. Therefore, this study aims to define and map the concept of laminitis using the bibliometric analysis technique.

MATERIALS AND METHODS

Database and Search Technique

Before designing a bibliometric study, the first step is to identify a proper database and an effective search strategy. In the current study, the Web of Science (WoS) database was employed. WoS is a widely used database in the academic community, known for its reliability, validity, and accuracy (Pranckutė, 2021; Sevinc, 2004).

The search criteria included selecting "English" as the language, "Article" as the document type, and "All Fields" as the search method. The studies retrieved from this search were thoroughly examined to enhance the reliability of the data. The data for this study was retrieved from the WoS core collection on April 10, 2024, using the inclusive term "laminitis" as the search query. The search yielded 1677 studies in the field of veterinary sciences. After applying article and language restrictions, a total of 1338 studies were achieved. After individually reviewing the studies, those that did not align with the subject matter and did not involve the cattle species were identified and excluded from the database. Finally, 967 studies were included in the analysis. (Figure 1).

Figure 1

Bibliometric Dataset Acquisition Process
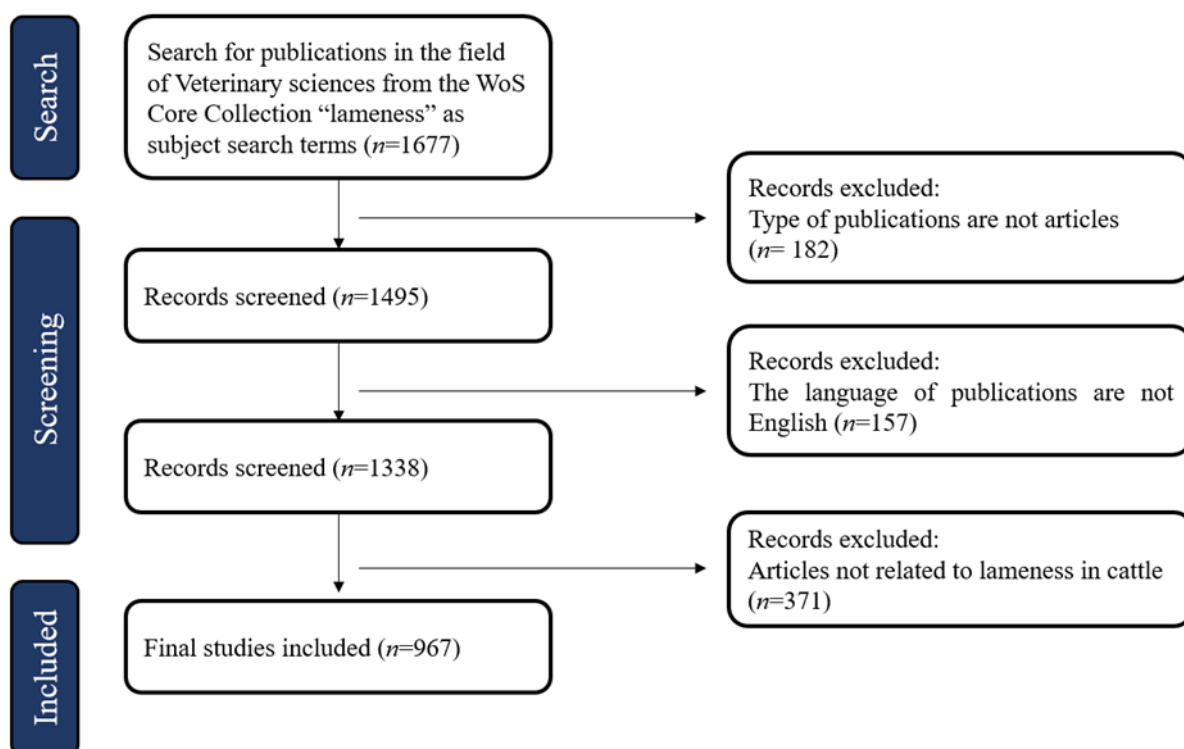
Bibliometric Research Methodology

In general, a bibliometric analysis comprises performance analysis and science mapping. Performance analysis reveals the contributions of research elements to the field, whereas science mapping reflects the relationships between these research elements. The effective integration of these two methods reveals both the structural and intellectual relationships within the research area under investigation (Baker et al., 2021; Tunger and Eulerich, 2018). Bibliometric studies typically assess parameters such as publication count, citation count, collaboration index, and h-index. Other evaluation criteria may also be taken into consideration (Aria and Cuccurullo, 2017).

RESULTS

Between 1980 and 2024, a total of 967 eligible research articles were published across 106 journals, involving 2872 authors. According to the author/article analysis, the average number of authors per article, the average number of articles per author, and the average number of co-authors per article were 2.97, 0.33, and 4.26, respectively. The numbers of single-authored and multi-authored articles were found to be 72 and 895, respectively. The collaboration index was determined to be 3.13 (Table 1).
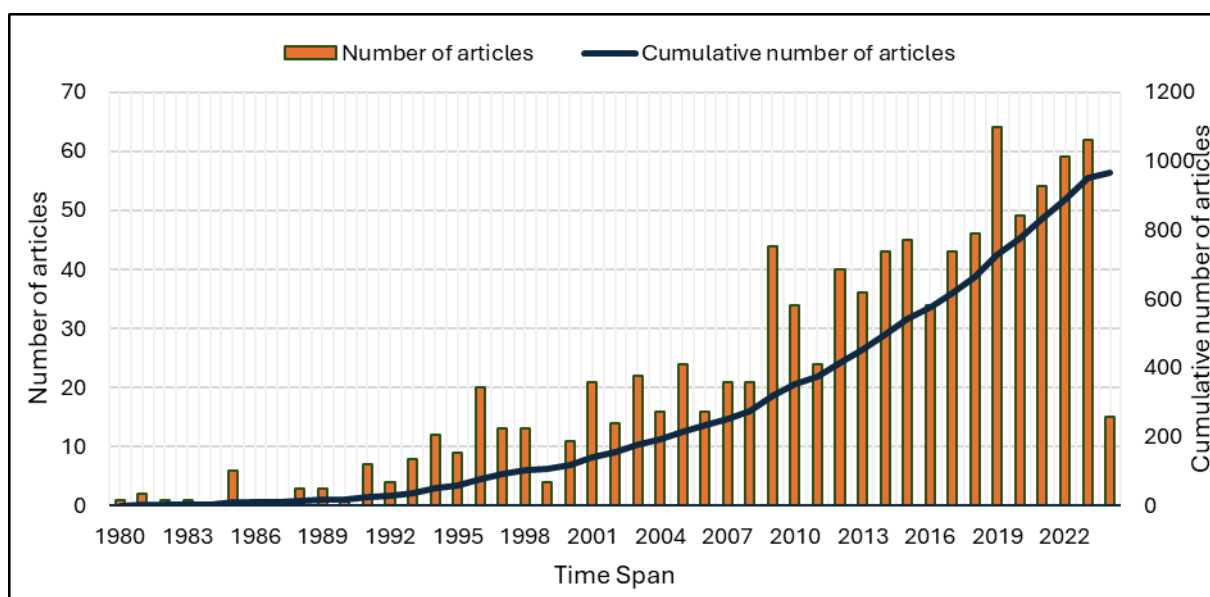
Table 1

Overview of the Laminitis Studies

Description	Results
Main Information About Data	
Timespan	1980:2024
Sources (Journals)	106
Documents	967
Annual growth rate %	6.35
Document average age	11.8
Average citations per document	23.41
References	16273
Document Contents	
Keywords Plus (ID)	1585
Author's Keywords (DE)	1841
Authors	
Authors	2872
Author appearances	4119
Authors of single-authored documents	62
Authors of multi-authored documents	2810
Authors Collaboration	
Single-authored documents	72
Multi-authored documents	895
Authors per document	2.97
Documents per author	0.33
Co-Authors per document	4.26
Collaboration index	3.13
Author footprint index	0.31
International co-authorships %	20.17
Document Types	
Article	917
Article; early access	2
Article; proceedings paper	48

The annual statistics of the publications about laminitis are given in Figure 2. An average

annual increase of 6.35% was observed in the number of research articles during the research period. The highest number of publications about laminitis was observed in 2019 with 64 articles (6.61%). Unlike other diseases, laminitis necessitates specialized treatment and preventive measures. It leads to significant economic losses for producers because it is influenced by all practices related to nutrition, housing, and yield (Tsousis et al., 2022). The observed increase in the publication count on laminitis can be explained by these factors and growing interest in the subject over time.

Figure 2

Annual Number of Publications on Laminitis (1980 – 2024)

Top Publishing Journals

Table 2 displays the top 10 most influential journals identified through the performance analysis. During the research period, a total of 967 research articles were published across 106 journals. The top 3 most influential journals were Preventive Veterinary Medicine 8.8% (85 articles), Animals 8.4% (81 articles), and Veterinary Journal 6.5% (63 articles) respectively. Upon detailed examination, it was discovered that these journals are open-access and consistently publish studies of high clinical quality in the field of veterinary sciences.

Table 2

The Top 10 Most Influential Journals on Laminitis

Rank	Journal	Frequency (%)
1.	Preventive Veterinary Medicine	85 (8.8)
2.	Animals	81 (8.4)
3.	Veterinary Journal	63 (6.5)
4.	Cattle Practice	59 (6.1)
5.	Veterinary Record	58 (6.0)
6.	Veterinary Clinics of North America-Food Animal Practice	41 (4.2)
7.	Animal	37 (3.8)
8.	Applied Animal Behaviour Science	34 (3.5)

9.	Animal Welfare	31 (3.2)
10.	Frontiers in Veterinary Science	29 (3.0)

Analysis of Authors

The survey data included 2872 authors who published 967 articles between 1980 and 2024. Among these authors, 62 published single-authored and 2810 multi-authored articles. As seen in Table 3, the top 3 most influential authors according to the h-index were Whay H.R. (17), Main D.C.J. (13), and Thomsen P.T. (13), respectively. Whay H.R., the author with the highest publication and citation counts on this subject, placed particular emphasis on animal welfare and behavior in dairy cattle. Since laminitis is an important disease that impairs animal welfare in dairy cattle, numerous studies have been conducted to better understand and address this important disease (Whay and Shearer, 2017). "Assessment of the welfare of dairy cattle using animal-based measurements: direct observations and investigation of farm records" published in 2003 and co-authored by Whay H.R., Main D.C.J., and Green L.E., has received 721 citations (Whay et al., 2003). This indicates high collaboration among the top 10 most influential authors.

Table 3

Top 10 Most Influential Authors on Laminitis

Authors	h-index	g-index	m-index	TC	TP	FPY
Whay HR	17	23	0.63	1485	23	1998
Main DCJ	13	15	0.59	963	15	2003
Thomsen PT	13	18	0.68	480	18	2006
Green LE	12	14	0.43	977	14	1997
Anderson DE	11	16	0.37	278	17	1995
Murray RD	11	13	0.34	1064	13	1993
Bergsten C	10	12	0.31	754	12	1993
Desrochers A	10	16	0.33	278	17	1995
Huxley JN	10	20	0.63	425	20	2009
Leach KA	10	10	0.36	624	10	1997

TP: Total Publications, TC: Total Citations, FPY: First Publication Years

Figure 3 illustrates the productivity of the top 10 most influential authors over time. Notably, the most influential author Whay H.R. published 4 articles in 2003, with an average of 21.86 citations per article. Among the most recent studies, Laven R.A. stands out with 4 articles published in 2023.

Figure 3

The Productivity of the Most Influential Authors on Laminitis Over Time
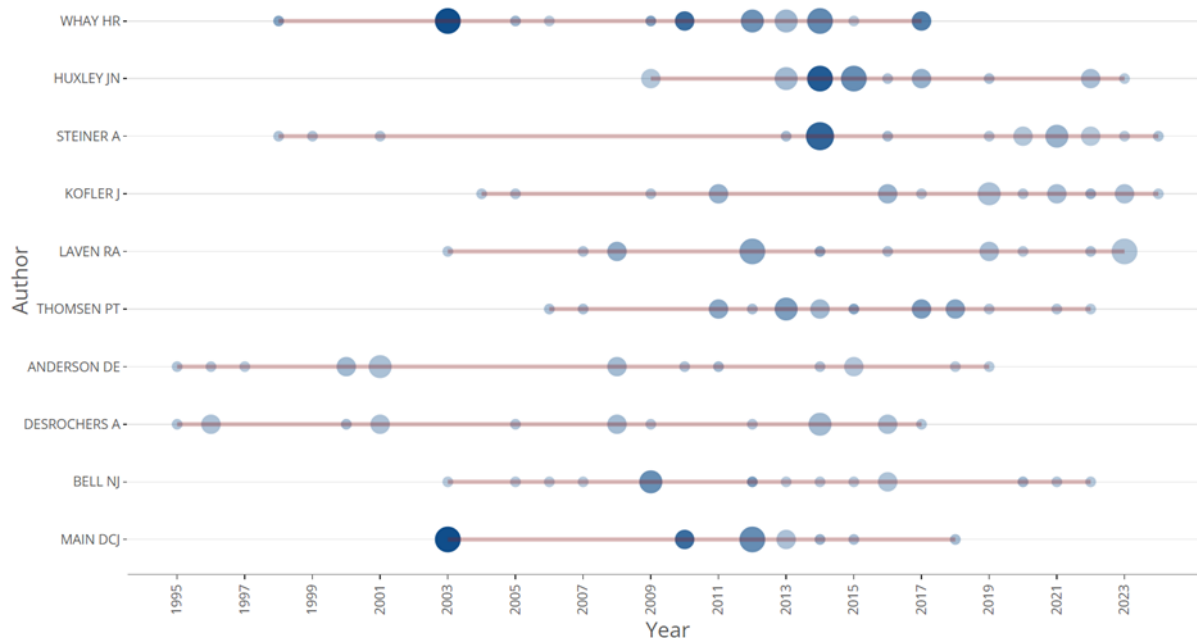

Note: The size of the nodes corresponds to a higher publication count, while the darkness of the color indicates a higher citation count.

Country Performances

Globally, 62 countries have contributed to the research on laminitis since 1980. The distribution of publication count of the corresponding authors' countries is shown in Figure 4. The top 10 countries include countries from different continents, including the United Kingdom, the United States of America (USA), New Zealand, and Brazil. The United Kingdom (201) was identified as the country with the highest number of publications on laminitis. The USA (24) had the highest multiple-county article count. New Zealand (33.3%) was identified as the country with the highest multiple-county article ratio. No country has exceeded an international collaboration rate of 50%. However, some countries showed stronger domestic collaborations. For example, the two most influential authors, Whay H.R. and Main D.C.J., were from the United Kingdom and have collaborated on some articles (Whay et al., 2003).

Figure 4

Publication Counts of the Corresponding Authors' Countries

SCP: Single Country Publications, MCP: Multiple Country Publications
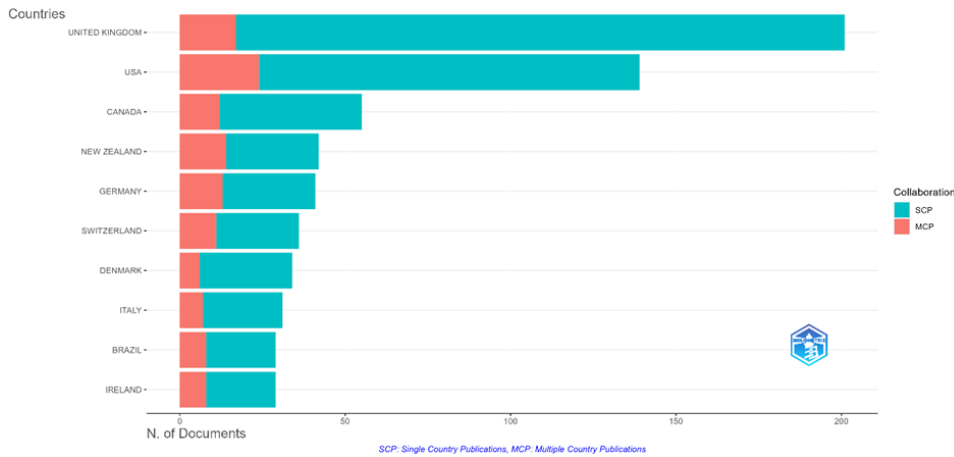
Co-Word Analysis

The tree map of high-frequency keywords occurring in the laminitis studies is shown in Figure 5. The most frequent 5 keywords were lameness 328 (22%), cattle 142 (9%), dairy cattle 135 (9%), dairy cow 99 (7%), and animal welfare 78 (5%), respectively. It was observed that "dairy cattle" (or dairy cow) is a frequently used keyword in laminitis studies involving cows. This finding can be attributed to the lactation and longer lifespan characteristic of dairy cattle (Thomsen et al., 2023). Since laminitis is associated with many factors, various keywords from diverse disciplines such as "animal welfare," "pain," "mastitis," "digital dermatitis," "surgery," "pasture," "fertility," and "management" frequently occur.

Figure 5

The Tree Map of the High-Frequency Keywords Occurring in Laminitis Studies
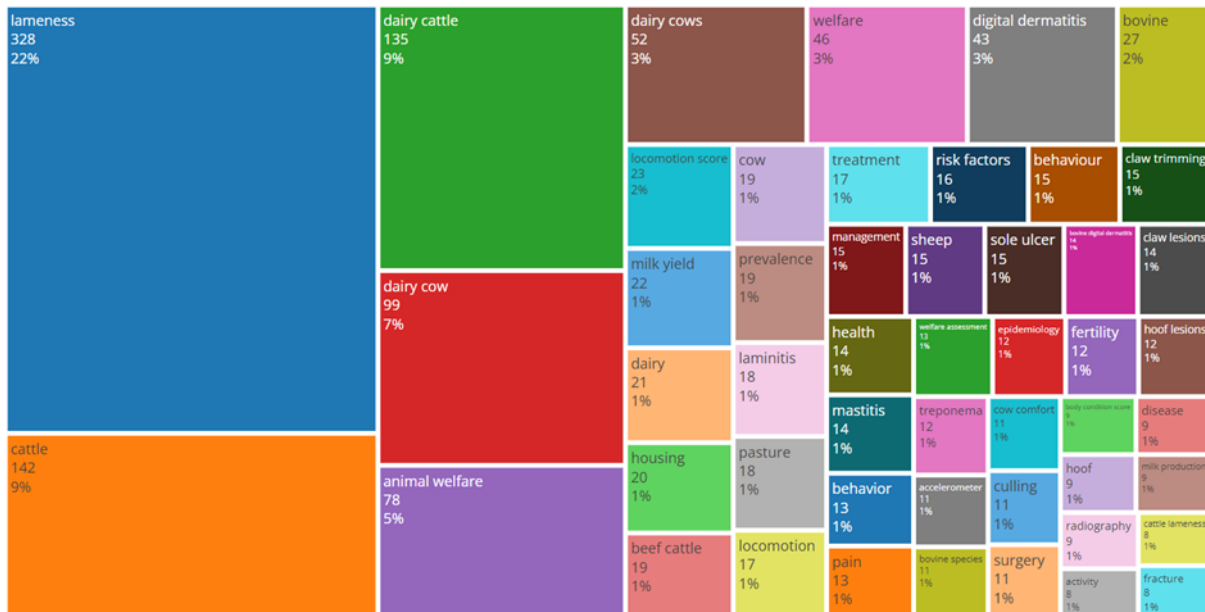
DISCUSSION

Laminitis in cattle results in substantial economic losses, particularly within the dairy farming sector. This is why studies on factors causing laminitis are still conducted globally. The protection measures developed can be implemented to varying extents depending on the modern production opportunities of the cattle farms in country or region. The protective measures developed can be

implemented to different extents depending on the modern production opportunities of cattle farms, as well as the country or region (Garvey, 2022). Since laminitis remains a significant challenge for dairy farmers, this study presented a bibliometric analysis to assess the intellectual development of studies in the field. The annual growth rate of studies on laminitis was determined to be 6.35%. A notable surge in the number of studies on laminitis was observed in 2009 and 2019. Furthermore, despite occasional decreases in certain years, there is an overall linearly increasing trend in the number of publications. Thomsen et al. reviewed 53 laminitis studies from 6 continents, with a predominant focus on Europe and North America, over a 30-year period. In that study involving 414950 cows from 3945 herds, the prevalence of laminitis ranged between 5.1% and 45%, with an average prevalence of 22.8% (Thomsen et al., 2023). According to the European Food Safety Authority (EFSA) Panel on Animal Health and Animal Welfare, a prevalence of detectable locomotor difficulties in dairy cattle exceeding 10% indicates that the prevention program is inadequate (EFSA, 2009). The significant challenge of combating laminitis has drawn the attention of researchers in the field. Through their collaboration, researchers from the United Kingdom, including Whay H.R., Main D.C.J., and Green L.E., have positioned their country as the most influential in this field. Brazil, a country with a high cattle population, has also ranked among the top 10 most influential countries in this field. Among the journals publishing laminitis studies, Preventive Veterinary Medicine, Animals, and Veterinary Journal were identified as the journals in the laminitis field with the highest impact factor. Studies in the field of laminitis are therefore of global interest to journals. Moreover, this global interest also encourages researchers to conduct new studies to explore potential treatment and prevention methods for this lesion. The fact that the most frequently occurring keywords in the field were from different veterinary sciences indicates that laminitis is a multifactorial disease. Besides, this finding also highlights the importance of multidisciplinary collaboration.

CONCLUSION

This study analyzed the literature on the laminitis using the data obtained from the WoS database. Accordingly, the most influential authors and journals, as well as the geographical distribution of the studies were identified and presented through tables and graphics. The findings indicated a rising trend in the number of research articles between 1980 and 2024. The analysis of the keywords indicated that laminitis is an important concern not only for animal welfare but also for behavioral sciences as well as economic loss. The results of this study offer a template for identifying hot research topics and future trends. Besides, this study allows for assessing the impact of the laminitis studies. This topic is likely to receive increased attention, particularly if research institutions are supported with proper policies and resources aimed at fostering studies on laminitis. In addition, co-operation between countries and studies on the effectiveness of preventive measures to combat laminitis should be carried out.

Strength and Limitations

This study serves as a guiding resource for researchers with an interest in laminitis. However, there are certain limitations to consider. Firstly, the review of laminitis studies relied solely on data from a single database. Nevertheless, the use of WoS provided a high-quality dataset, as it includes a larger number of articles in this field compared to Scopus or PubMed. Only research articles in English were included in the dataset. Additionally, it's important to note that since WoS counts an article once for each author, certain countries' statistics might be inflated. However, the articles obtained by the search were meticulously reviewed to ensure their direct relevance to the subject matter, and studies deemed unsuitable were excluded from the analysis. Despite these limitations, the findings offer sufficient evidence to reveal the research trends of authors and countries in the field of laminitis and to track the development of the field over time.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Hakan SERİN and Muslu Kazım KÖREZ. The first draft of the manuscript was written by Hakan SERİN and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

There is no conflict of interest between the authors.

Sustainable Development Goals (SDG): 3 Good Health and Well-Being

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