A bibliometric analysis of research trend on hypomagnesemia in calves

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ABSTRACT

Hypomagnesemia, or low blood magnesium, is a significant metabolic disorder in calves and cattle, often leading to neurological symptoms and, if untreated, high mortality. Bibliometric analysis is an essential tool for assessing articles and other publications in literature. In this study, we performed a comprehensive analysis of global trends research on hypomagnesemia in calves. By first of October 2025, the data were gathered from the WoS database (WoS). VOSviewer software was used to present the network among studies for each item under study, with an emphasis on the top ten outcomes for each item. Co-occurrence analysis, citation analysis and bibliographic coupling were performed. In total, 784 articles were included in the bibliometric analysis. The results revealed that author Timasheff, S was the most productive author (11, 1.4 %), and the publications in 2019 (n=27) were at the forefront. Regarding funding agencies, the National Institutes of Health, USA was in the front (n= 30) and the USA was the top nation in publications (n =148). The highest publications in WoS categories were collected from Veterinary Sciences (308, 39.28 %). Research articles were the most abundant form (n=705, 89.92 %). Citation analysis revealed that there were 12077 citations for the 784 articles on hypomagnesemia with an average citation of 14.47. Research related to hypomagnesemia in calves has grown in a fluctuating manner between 2016 to 2025. The results indicate that hypomagnesemia in calves is an important clinical problem in food animal practice and reflects its economic significance worldwide.

Introduction

Hypomagnesemia, or low blood magnesium, is a significant metabolic disorder in calves and cattle, often leading to neurological symptoms and, if untreated, high mortality. The condition is primarily linked to dietary deficiencies, impaired absorption, and environmental or physiological stressors, making prevention and early intervention critical for herd health (Constable *et al.*, 2016).

The most common cause is insufficient magnesium intake, especially in rapidly growing calves or those on high-protein diets, which can interfere with magnesium absorption (Pinotti *et al.*, 2021; Hassan *et al.*, 2023)

High potassium and nitrogen in lush pastures, particularly during spring or autumn, reduce magnesium uptake in the rumen (Zelal, 2017; Doncel *et al.*, 2019; Pinotti *et al.*, 2021). Stress from weather, transport, or rapid growth increases magnesium requirements and can precipitate hypomagnesemia (Zelal, 2017; Hassan *et al.*, 2023). Calves have limited magnesium reserves, making them especially vulnerable to sudden changes in intake or absorption (Hassan *et al.*, 2023).

Nervousness, muscle spasms, convulsions, tetany, and rapid death are typical in severe cases (Zelal, 2017; Hassan *et al.*, 2023). Reduced appetite, poor growth, anemia, reproductive issues, and increased susceptibility to infections may occur with milder or chronic deficiency (Abramowicz *et al.*, 2021). Hypomagnesemia can also impair calcium homeostasis, increasing the risk of hypocalcemia and related disorders (Goff, 2006; Pinotti *et al.*, 2021).

Confirmed by low serum or plasma magnesium; cerebrospinal fluid magnesium may better correlate with neurological signs (Cantón *et al.*, 2022; Hassan *et al.*, 2023). Regarding treatment, oral or intravenous magnesium supplementation (e.g., magnesium oxide) is effective. Herbal additives like basil and thyme have also shown benefit (Doncel *et al.*, 2019; Hassan *et al.*, 2023). Ensuring adequate dietary magnesium, especially during high-risk periods, and correcting mineral imbalances in feed are key strategies (Doncel *et al.*, 2019).

In scientific studies, bibliometric analysis is conducted in various forms. The most popular techniques include citation, co-citation, co-occurrence, bibliographic coupling, and co-authorship analysis (Van Eck and Waltman, 2014). Although hypomagnesemia in calves has drawn worldwide attention, especially food animal producers, there is no bibliometric analysis on research production regarding this topic. therefore, the aim of the present study was to provide an analysis of the research production on hyponatremia in calves and its clinical value worldwide.

Materials and methods

Searching plan and data source

We implemented a highly effective and clear strategy for conducting bibliometric analysis that merits attention. By meticulously examining research studies, we have gained invaluable insights into the extensive body of work dedicated to hypomagnesemia in calves. To ensure robust analysis, we sourced our data from prime databases, employed optimal search strategies, and meticulously refined the data before proceeding to analysis and visualization. Our comprehensive analysis encompasses research sourced from the prominent Web of Science Core Collection (WoSCC) and the Science Citation Index Expanded (SCI-E) database (https://webofknowledge.com/). By strategically utilizing key terms including "Hypomagnesemia," "magnesium deficiency" and "Calves". Our search was concentrated on the WoS topic field, which involves titles, abstracts, and author keywords. In this bibliometric analysis, all studies on hypomagnesemia in calves including original articles, reviews, and book chapters were included. Retracted, and corrected articles as well as, biographies, and poetry are excluded.

Data Analysis

Authors, affiliations, published nations, citation themes, WOS categories, publication type, languages, research areas, funding agencies, publishers, journals, and publishing years were all included in the search results. For assessment and analysis, the data were imported into Microsoft Excel. Furthermore, using specialized software (VOSviewer, ver-

sion 1.6.14), correlations between the most productive nations, research institutes, and commonly used terms were examined. The downloaded dataset was loaded into the VOSviewer program in Plain Text file format and contained all records and cited references. Co-citation, coupling institutions, and coupling documents. Additionally, cluster analyses and social network maps for nations, organizations, and keywords (made up of nodes and links) (Mulet-Forteza *et al.*, 2019). In accordance with the number of studies included (12,404) and the results of the analysis, the minimum frequency of keyword occurrence in the publications was established two or four times, respectively. Various nodes of a map represent various things, such as a nation, organization, or keyword. The number of publications or frequencies is reflected in the size of the nodes; the larger the node, the higher is the number of publications or frequencies (Liang *et al.*, 2017). Additionally, the relationships between co-occurrence, co-citation, and collaboration are represented by the links between nodes. Different clusters are represented by the colors of the lines and nodes (Gao *et al.*, 2019).

Results

In all, 784 publications were chosen for our bibliometric analysis, comprising 17 (2.16) reviews and 705 (89.92 %) full-length original research papers. Over the last ten years, there has been a noticeable increase in the number of publications annually, with the maximum rate in 2019 (Figure 1).
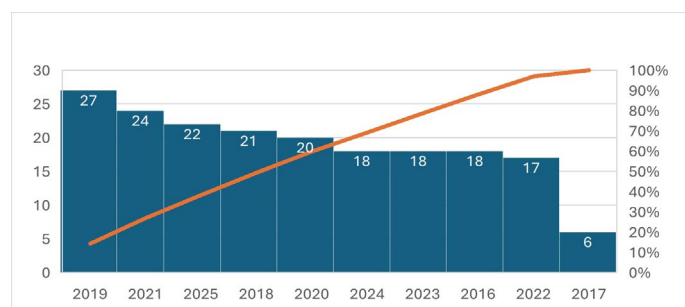

Figure 1. Top ten annual distribution of publications on hypomagnesemia in calves.

Table 1 shows the top-ten researcher profiles that worked on hypomagnesemia in calves. Timasheff, S is in front of authors with the highest production (11, 1.4 %) publications, followed by Roche, J (1.14%), Smith, RH (1.14%), Valadares Filho, SC (1.14%), Miller, W (0.98%), Goff, J. (0.98%), Neathery, MW (0.76%), Beynen, AC (0.76%), Wensing, TH (0.76%) and finally Shattuck, JK (0.63%).

Table 1. Top ten author profiles who have the highest production on hypomagnesemia in calves.

Author	Number	%
Timasheff, S	11	1.40
Roche, J	9	1.15
Smith, RH	9	1.15
Valadares Filho, SC	9	1.15
Miller, W	7	0.89
Goff, J.	7	0.89
Neathery, MW	6	0.77
Beynen, AC	6	0.77
Wensing, TH	6	0.77
Shattuck, JK	5	0.64

Figures 2-3 show the VOSviewer network visualization of co-authorship to organization and country. We identified the top 10 high-producing institutions based on the number of articles published and their scores (Table 2). With 6 publications, the University of Florida Department of Animal Sciences was the leader institute.
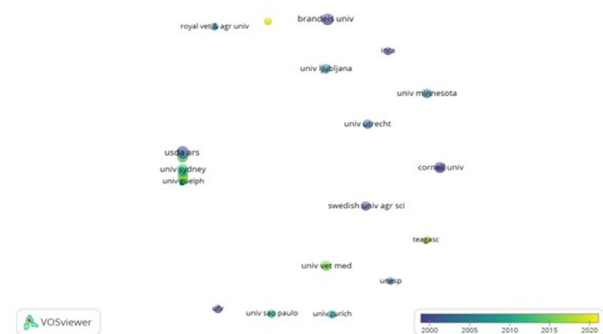

Figure 2 Vosviewer network visualization of co-author to organization for research on hypomagnesemia in calves.
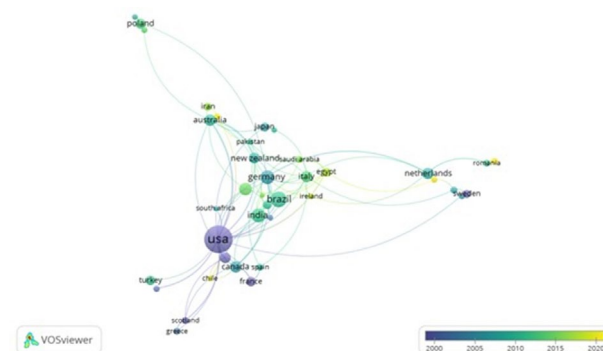

Figure 3. Vosviewer network visualization of co-author to country for research on hypomagnesemia in calves.

Table 2. Top ten institutes are participating in research on hypomagnesemia in calves.

Affiliations	Count	%
Ferdowsi University of Mashhad Faculty of Veterinary Medicine	4	0.51
Massey University College of Sciences	6	0.75
Massey University School of Veterinary Science	4	0.51
The University of Auckland Faculty of Science	4	0.51
The University of Sydney Faculty of Science	6	0.75
The University of Sydney School Oof Veterinary Science	5	0.63
University Of Florida Department of Animal Sciences	6	0.75
University Of Florida Institute of Food and Agricultural Sciences	6	0.75
Utrecht University Faculty of Veterinary Medicine	5	0.63
Vetsuisse Faculty Bern and Zurich	5	0.63

As shown in Table 3. The top ten WOS categories for all 784 publications were Veterinary Sciences (308, 39.28 %) followed by Agriculture Dairy Animal Science (221, 28.18 %), Biochemistry Molecular Biology (112, 14.28 %), Food Science Technology (69, 8.8 %), Biophysics (29, 3.69 %), Agriculture Multidisciplinary (28, 3.57 %), Endocrinology Metabolism (25, 3.1 %), Food Science Technology (23, 2.9 %), Zoology (19, 2.42 %), and Agronomy (14, 1.78 %),

Table 3. Top ten web of science categories of articles published on hypomagnesemia in calves.

Category	Number	%
Agriculture Dairy Animal Science	221	28.19
Agriculture Multidisciplinary	28	3.57
Agronomy	14	1.79
Biochemistry Molecular Biology	112	14.29
Biophysics	29	3.70
Endocrinology Metabolism	25	3.19
Food Science Technology	69	8.80
Nutrition Dietetics	23	2.93
Veterinary Sciences	308	39.29
Zoology	19	2.42

Regarding funding agencies, Table 4 shows the top-ten funding agencies. Where National Institutes of Health, USA were in the front (n= 30).

Table 4. Top ten funding agencies for research on hypomagnesemia in calves.

Funding Agencies	Count	%
National Institutes of Health USA	30	3.82
National Institute of General Medical Sciences	15	1.91
Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior	10	1.27
National Natural Science Foundation of China	10	1.27
National Cancer Institute	10	1.27
Conselho Nacional de Desenvolvimento Cientifico e Tecnologico	7	0.89
Fundacao de amparo a Pesquisa do Estado de Sao Paulo	5	0.63
New Zealand Ministry of Business Innovation and Employment	4	0.51
China postdoctoral Science Foundation	3	0.38

Citation analysis revealed that there were 12077 citations for the 784 articles on hypomagnesemia with an average citation of 14.47. Figure 4 shows the VOSviewer network for citations to documents.
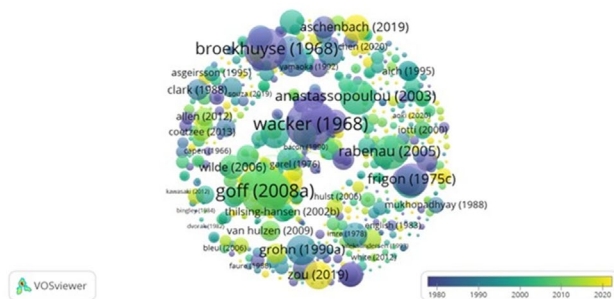

Figure 4. Vosviewer network visualization of citation to document for research on hypomagnesemia in calves.

Because keywords are usually high-level summaries of articles, they are ideally suited for investigating research hotspots and trends. We conducted a co-occurrence analysis to pinpoint the most prominent and emphasized content, subjects, or keywords related to rabies. A minimum occurrence threshold of five for each keyword was established. Figure 5 illustrates the VOSviewer network showing the keywords most frequently associated with rabies. The size of each node reflects the frequency of keyword occurrences across various studies. Furthermore, the lines connecting the nodes indicate that the two linked keywords co-occurred in a research publication, and the thickness of the line signifies the number of co-occurrences.
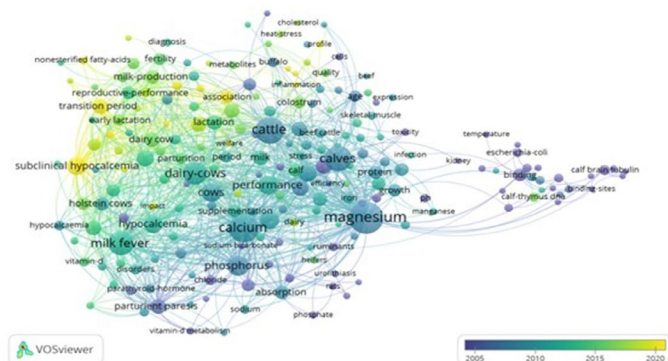

Figure 5. Vosviewer network visualization of co-occurrence to all keywords for research on hypomagnesemia in calves.

The Bibliographic coupling document displays information regarding the documents, sources, and authors, as shown in figures 6-7. Node size reflects the extent to which the document or author is bibliographically coupled.
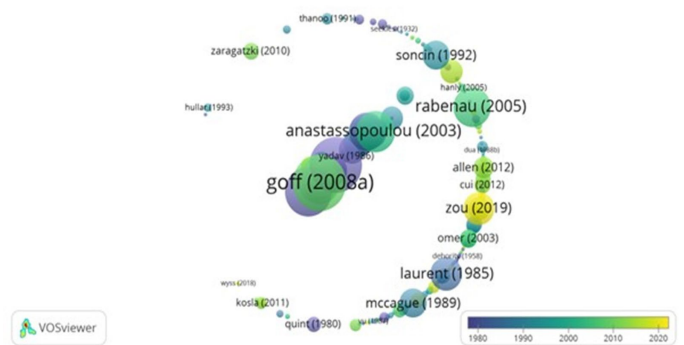

Figure 6. Vosviewer network visualization of Bibliographic coupling to document research on hypomagnesemia in calves.
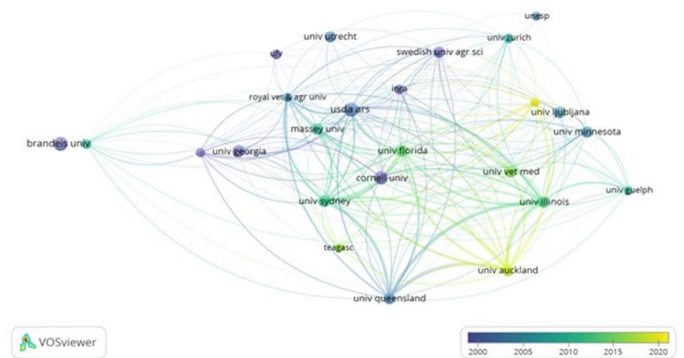

Figure 7. Vosviewer network visualization of Bibliographic coupling to organization for research on hypomagnesemia in calves.

Discussion

According to the present bibliometric analysis, 89.92 % of the published studies on hypomagnesemia in calves were research articles, and 2.16 % were review articles. This indicates that most of the published studies were experimental rather than theoretical in nature. Over the past period, the trend of publications per year has increased, with 2019 showing the highest number of publications. The sensitive nature of the disease in the world and the availability of funds to support research that results in publications could be the cause (Emam *et al.*, 2023)

The United States was the most productive nation in terms of hypomagnesemia in calves research and publication (n=152), followed by Brazil (n=47) and the India (n=47). This may be attributed to the awareness about the risk and importance of the disease (Emam *et al.*, 2023). In addition, there is a presence of funding agencies which support conducting studies on the disease (Kim *et al.*, 2019). It is evident from the funding sources that the top two funding agencies were from the United States. Together, they provided 30 funding for hypomagnesemia research. This pattern indicates that research and publications in a particular field of study are directly affected by the total amount of funds allotted for the disease. The University of Florida Department of Animal Sciences, Massey University College of Sciences, and the University of Sydney Faculty of Science shared equal contribution for articles production. The number of citations an article receives is heavily dependent on the year of publication. The year 2021 was a big year for citations, and many papers published in that year received hundreds of citations. In addition to other factors, the topic of an article greatly influences the number of citations received. The paper of Goff (2008) was the most cited (n=398 citations).

The WoS Core collection was chosen for this study because of its systematic approach to gathering and assessing scholarly articles, which is generally regarded as optimal for in-depth bibliometric analyses. Over 252 subject categories in the arts, humanities, social sciences, and sciences are included in the WoS. The category with the highest number of articles in the current study was Veterinary Sciences (308, 39.28 %). Each journal was assigned to one or more topic groups to implement this

scheme. However, overlapping coverage of categories may arise because it is frequently challenging to designate a journal as a single group. All subject categories allocated to the parent journal are sent to each published item (Birkle *et al.*, 2020).

In the present analysis, citations to documents, authors, institutes, and countries were achieved using Vosviewer. Goff (2008) was the most cited author, and the USA was the most cited country. The goal of citation analysis is to quantify the impact of pertinent scientific research units including authors, journals, and institutions (Hallinger and Kovačević, 2021). Citations, which are regarded as the most important indicators of efficacy, rank, and quality, are anticipated to increase in these research units (Donthu *et al.*, 2021). Co-citation analysis was first used by Henry Small to identify an institution's strengths and flaws (Surwase *et al.*, 2011). Additionally, a strong co-citation relationship is indicated by a co-citation analysis, which displays whether the two study units appear together in the bibliography (Van Eck and Waltman, 2014). Furthermore, using theme clusters formed by the connections between these concepts, co-occurrence analysis makes sense of concepts that are frequently found in abstracts, titles, or even keywords of publications, and displays them as a network (Donthu *et al.*, 2021).

In the present work, utilizing Vosviewer, we achieved a co-occurrence analysis to determine the most focused and amplified content, topics, and keywords in hypomagnesemia in calves' research. The Vosviewer network showed seven clusters, the largest of which had 159 items. Magnesium, calves, and cattle were mostly found in the co-occurrence analysis of all the keywords. Co-occurrence analysis offers insights into the most common ideas, trends, topics, and patterns that may be considered in future planning of scientific research (Wang and Chai, 2018).

The bibliographic coupling of documents and authors is one of the most crucial factors for the study of publications. In the present study, the documents of Anastassopoulou (2003) and Rabenau (2005) were the most coupled, and Goff (2008) was the most bibliographically coupled author. Two documents from two different organizations were combined to cite the third document in this analysis. Bibliographic coupling strength is one way to assess bibliographic coupling (Moed, 2006). Recent research publications with fewer citations are also considered. Bibliographic coupling displays all current studies, and old studies appear in the co-citation analysis. It shows the current status of the intellectual structure in a given scientific trend (Boyack and Klavans, 2010). Research has shown that coupling analysis is more robust than co-citation analysis (Zhao and Strotmann, 2015).

The limitations of this study should be acknowledged. Firstly, we used one database (WoS), which does not include all studies worldwide. However, the WoS database provides sufficient credible studies in comparison to other databases.

Conclusion

Research related to hypomagnesemia in calves has grown in a fluctuating manner between 2016 t0 2025. The results indicate that hypomagnesemia in calves is an important clinical problem in food animal practice and reflects its economic significance worldwide.

Acknowledgments

Conflict of interest

The authors have no conflict of interest to declare.

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