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Gastrointestinal Ultrasound in Dogs: Scientometric Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study is to evaluate, through a scientometric analysis, the scientific production of studies related to intestinal ultrasonography in dogs. For this purpose, using the Web of Science database, articles published between 2014 and 2023 were selected. The initial screening of the studies resulted in the selection of 103 papers, of which only 10 were included in this research after evaluating the criteria related to the theme and methodology used. Data collection consisted of gathering information on publication date, authors, journals, countries, keywords, document type, areas of knowledge, objectives, institutions, and relevant information on the subject. The results

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show a cycle of 3 publications up to the year 2021, as well as keywords related to the topic but aligned with other areas, such as neonatology. Other findings included the identification of 48 authors, two articles restricted to the topic, greater participation from Italian universities in the publications, and a main focus on intestinal ultrasonography. It is concluded that this study is of great importance, as it provides greater transparency and open access to scientific research.

Keywords: Utrasound; intestine; dog.

1. INTRODUCTION

Ultrasonography (USG) of the gastrointestinal (GI) tract has already established itself as an important complementary diagnostic modality in small animal clinical practice, mainly because it is a non-invasive, dynamic exam with practical application in routine clinical settings (Larson and Biller, 2009), (Malancus and Tofan, 2017).

GI tract USG provides information on the thickness and stratification of the layers of the intestinal wall, evaluation of motility, and visualization of adjacent structures (Larson and Biller, 2009).

The mural stratification pattern of the intestinal segments comprises five distinct layers (Penninck, 2008), (Goggin et al., 2000), (Silva et al., 2013). Considering the intestinal lumen, the layers are mucosa, submucosa, muscularis, and serosa. The mucosa and muscularis are hypoechoic, while the submucosa, serosa, and luminal surface are hyperechoic (Penninck, 2008).

Ultrasonographic imaging assists in verifying the changes caused by enteropathies, thereby advancing the diagnosis of gastrointestinal alterations, which is crucial for appropriate treatment and resolution of the animal's clinical condition (Silva et al., 2013).

GI USG examination contributes valuable information toward diagnostic consolidation. However, limitations such as the presence of gas and large fecal volumes, and artifact formation like reverberation and comet tail, must be considered (Santos, 2009), (Penninck et al., 2009).

It is understood that performing an abdominal scan of the patient in dorsal recumbency allows for good visualization of the GI tract. However, in some cases, it may be necessary to position the animal in lateral recumbencies to redistribute gas and liquid within the stomach and intestines. Whenever possible, the patient should be fasted for 6 to 12 hours before the exam to reduce the amount of ingesta and artifacts (Feliciano et al., 2019).

The objective of this scientometric analysis is to evaluate the scientific production of studies on canine intestinal USG, exploring the main presumptive findings in the diagnostic approaches for intestinal diseases and contributions to the literature. To this end, the aim is to quantify the number of publications per year on the topic, highlight the main authors, institutions, scientific journals, and countries that publish the most on this subject, emphasize the main objectives of the evaluated studies, classify the works by type, identify the area of knowledge in which the studies are classified, and describe the key findings and alterations reported in intestinal USG studies.

2. MATERIALS AND METHODS

This study has a quantitative, descriptive, and analytical focus. Data were collected from the Web of Science database using the following keywords: Ultrasound, Intestine, and Dog. There were no exclusion criteria regarding the language of the articles, so documents published in various languages were accepted for evaluation in the research. Initially, no filters were applied regarding the date, allowing for a broad evaluation of the production. The articles generated by the search were first subjected to abstract reading and later to a new evaluation for study inclusion.

A total of 103 works were found using the previously mentioned keywords. Subsequently, the inclusion criterion of being a scientific publication from the last 10 years was applied, admitting articles from 2014 onwards, which led to the exclusion of 49 articles. After detailed reading of the abstracts of the remaining 54 (100%) articles, 31 (57.41%) did not have USG as the focus of the study or did not base their methodology on ultrasonographic evaluation of the intestine, 7 (12.96%) of the ultrasonographic

findings involved wild or exotic animals, and 6 (11.11%) were comparative ultrasonographic studies between dogs and cats or exclusively on felines, so all these were excluded. Thus, 10 articles (18.52%) were finally included, all of which were in English and obtained from original and case report articles, with two of them (20%) being available in closed access.

From the selected publications, the following data were evaluated for analysis: year of article publication, author names, name of the journal where it was published, country of publication, keywords used in the studies, type of document published (original article, review, or case report), area of knowledge, study objectives, relevant findings, and institutions of the affiliated authors.

Based on the full reading of the abstracts and results of the studies, the data were compiled and organized into spreadsheets using Microsoft Excel® according to each research variable, as mentioned above. From there, they were analyzed using descriptive statistics (categorical variables) with the bibliometrix package in R and subjected to further evaluation for discussion.

3. RESULTS AND DISCUSSION

For the precise execution of this scientometric study, it was necessary to establish filters applied to the search results from the platform to specifically focus on publications related to the subject of this research. Within the pre-established 10-year period, a limited number of publications were quantified.

A significant gap between 2016 and 2017 was observed, with no registered publications during this time, followed by a continuous cycle of 3 publications until 2021, when the first and only peak was recorded with 3 publications in the same year. This was contrasted by the next two years, with 1 and 2 publications, respectively.

The most frequently used keywords for title formulation by authors, ranked in the top three, are: dogs, fetal, and sonographic. The appearance of terms associated with neonatology highlights articles included in the research that specifically aimed at the study of fetal gastrointestinal motility and fetal intestinal peristalsis, as detailed in Table 1.

The justification applies similarly, relating to the casual dispersion of keywords chosen by the authors, as shown in Fig. 1. It highlights the high frequency of terms such as ultrasound, canine, and intestine. It is important to note that repeated words between the title and keywords are usually infrequent, with terms of similar meaning or semantics prevailing instead. Among 37 keywords, the top three most used accounted for 29.73%, nearly a third of all other chosen terms, with the most used representing 13.51% on its own.

Fig. 1. Word cloud showing the dispersion of the impact of the keywords used in the articles listed

Table 1. Description of the selected articles in the Web of Science database

Article	Year	Type of study	Objective
(Ehrhardt et al)	2023	Case Study	Report on ultrasound and radiographic findings in a case of jejunal volvulus torsion in a dog.
(Magistris et al.,)	2023	Original Article	To determine the sonographic characteristics of canine intestinal lipogranulomatous lymphangitis.
(Siena et al.,)	2022	Original Article	To quantify fetal intestinal motility in relation to days before delivery, maternal size and sex ratio in dogs.
(Linta et al.,)	2021	Original Article	Evaluating the feasibility of contrast-enhanced ultrasound for assessing duodenal perfusion in dogs with inflammatory bowel disease.
(Yaffe et al.,)	2021	Original Article	To describe the ultrasound appearance caused by parasite migration, and the effectiveness of ultrasound in differentiating between causes of septic peritonitis.
(Malancus,)	2021	Original Article	Evaluate changes in ultrasound and endoscopic results in dogs suffering from intestinal disorders.
(Moshnikova et al.,)	2020	Original Article	Comparing the prevalence and extent of echographic changes associated with schistosomiasis between affected and non-infected dogs.
(Corda et al.,)	2019	Original Article	To evaluate the diagnostic accuracy of ultrasound for the diagnosis of intestinal toxocariasis in newborn puppies during the pre-patent period.
(Mapletoft et al.,)	2018	Original Article	Evaluating the usefulness of abdominal ultrasound in diagnosing dogs with diarrhea.
(Elaine et al.,)	2015	Original Article	To correlate the development of the fetal intestine with gestational age.

Table 2. Specification of the articles selected in terms of country, affiliation and number of citations of the work

Article	Country	Affiliation	Quotes
(Ehrhard et al.,2023)	USA	University of Florida	2
(Magistris et al.,2023)	Italy	University of Bologna	1
(Siena et al.,2022)	Italy	University of Padua	4
(Linta et al.,)	Italy/Switzerland	University of Bologna; University of Zurich	5
(Yaffe et al.,2021)	Israel	Hebrew University of Jerusalem	-
(Malancus,)	Romania	Iasi University of Life Sciences	12
(Moshnikova et al.,2021)	USA	University of Minnesota System	4
(Corda et al.,2019)	Italy/Spain	University of Sassari; University of Zaragoza	7
(Mapletoft et al.,)	United Kingdom/USA	University of London Royal Veterinary College, Iowa State University	7
(Elaine et al.,2015)	Brazil	Federal University of Paraná	33

Table 3. Comparison of selected articles by area of knowledge and results among the top 5 most-cited journals

Article	Areas	Results	Periodical
(Elaine et al., 2015)	Imageology Gastroenterology Neonatology	Ultrasound is relevant for monitoring the development of peristalsis, but it is not possible to determine echographically whether the intestine is functional.	Elsevier Science Inc
(Malancus, 2021)	Imageology Gastroenterology	Ultrasound has shown that there is an extremely significant statistical correlation between the presence of spots and dilated lacteals in dogs with lymphangiectasia.	Arquivo Brasileiro Med. Vet. Zootecnia
(Corda et al., 2019)	Imageology Gastroenterology Parasitology	Early ultrasound diagnosis of T. canis infection in puppies could help control the disease in dogs and reduce the zoonotic risk to the human population.	Springer
(Mapletoft et al., 2018)	Imageology Gastroenterology	The most frequent result was the absence of echographic abnormalities affecting the intestine in 65 dogs (44%), USG in dogs with diarrhea should be followed up by a clinician.	Wiley
(Linta et al., 2012)	Imaginology Gastroenterology	The duodenal wall showed a typical perfusion pattern characterized by radial and simultaneous enhancement of the wall in all dogs.	Wiley

Among the 10 selected articles, original research papers predominated (Table 1). Generally, the main objective of all the articles in the table was to describe, determine, evaluate, or quantify how and to what extent ultrasonography could provide the expected outcome for the research on a specific intestinal segment, with variations in age and sex, ultimately generating productive results.

The intestines have vast physiological complexity, making it understandable to notice divergent scientific content on this single part of the animal's body, particularly when compared to the diversity of clinical research applications.

When analyzing the distribution of authorship, 48 authors participated in the 10 publications, with an average of 4.8 co-authors per paper. Only one of these was a single-author publication, which was included in the group of the five most-cited papers within this study (Table 3).

Among all the articles reviewed, read, and tabulated, two stood out due to restricted access to their full content, only making the abstract, author information, publication dates, affiliations, and journals available on the platform. These documents were still considered suitable for inclusion in this study.

Table 2 presents the affiliations of the authors involved in the studies, the country of the institution, and the number of citations for each article since publication.

In this regard, it can be concluded that universities in Italy held a prominent position within this scientometric study, with four articles published, two of which were from the same university, considered a highly influential scientific institution worldwide. The remaining two were published in collaboration with institutions from two other countries.

Two of these Italy-involved papers were listed in the table ranking citations, showing the journals in which they were published. Both were published in collaboration with universities in Switzerland and Spain. The United States appeared in three studies from three different universities, one of which was published in collaboration with an institution from the United Kingdom. This collaborative study also ranked among the top five most-cited articles.

Despite Italy's strong representation in terms of citation numbers, the most-cited paper was affiliated with a Brazilian university, ranking first with the highest number of references. This document was made available on the Elsevier Science journal platform.

The results include the main findings or significant alterations reported in the five most relevant articles according to citation rankings. While the primary focus remained on the gastrointestinal USG, one of these papers stood out for its focus on fetal intestinal motility, having the highest citation count, and another highlighted the identification of parasites in puppies through ultrasonographic imaging.

This study aimed to analyze the scientific production on gastrointestinal USG in dogs, applying scientometric methods to understand the distribution of publications and identify specific patterns. The analysis revealed a scarcity of studies focused on this topic, underscoring the importance of promoting this technique as a crucial diagnostic method in veterinary practice. This observation aligns with (Macias-Chapula, 1998) findings, which emphasize scientometric analysis as an essential component for advancing knowledge.

The selection of articles, based on specific criteria and a 10-year period, resulted in a refined sample of 10 studies, which is consistent with (Zitt and Bassecoulard, 1994) principles regarding the importance of precise inclusion criteria in scientometric analyses. The temporal distribution of publications suggests cycles of scientific productivity, with a gap between 2016 and 2017, followed by a rise in 2021. This pattern may reflect shifts in research priorities or technological advancements, as noted by (Cozzens and Van, 2019) who discuss the cyclical nature of scientific output.

The analysis of article titles indicated a focus on the terms dogs, fetal, and sonographic, revealing a growing trend in research on canine fetal USG. This trend aligns with previous studies, such as those by (Siena et al., 2022), (Elaine et al., 2015) which explored the application of this technique in evaluating canine fetuses, highlighting both its potential and the challenges in expanding this research field.

Moreover, the predominance of original articles (9 out of 10) reflects the innovation and depth of research in this area, suggesting a field that is continuously developing. The average of 4.8 co-

authors per article and the high level of collaboration across different specialties emphasize the multidisciplinary nature of veterinary USG research, consistent with the literature on scientific collaboration in specialized fields.

Finally, the analysis of author affiliations revealed the prominence of institutions in Italy and the United States, with a Brazilian article leading the citation ranking. This highlights the global relevance of the research and Brazil's significant contribution to the advancement of gastrointestinal USG in dogs.

4. CONCLUSION

This scientometric study highlighted a limited number of publications over a decade, with a significant increase in 2021, possibly reflecting a resurgence of interest. The predominance of original articles underscores the depth and innovation in the field, with a specific focus on fetal motility and sonographic aspects. The analysis also revealed strong international collaboration, evidenced by the participation of renowned institutions from different countries, highlighting the importance of global partnerships for advancing scientific knowledge and disseminating advanced clinical practices. However, restricted accessibility to some documents may limit the comprehensive analysis of the results. This study emphasizes the importance of greater transparency and open access to research. To advance knowledge and improve clinical practices, it is essential to promote continued research and strengthen global collaboration.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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