

TAPHONOMY IN BRAZIL: OVER 36 YEARS OF HISTORY AND NEW INSIGHTS

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ABSTRACT – This study presents a historical and quantitative overview of the development of taphonomic research in Brazil from its early milestones to recent trends. The analysis highlights key publications, academic theses, and institutional initiatives that have shaped the field since the late 1980s. A significant growth in scientific output is observed from 2011 onwards, culminating in a peak number of publications in 2024. Despite this progress, research remains concentrated in the Southern, Southeastern, and Northeastern regions, underscoring the need to expand investigations into the Central-West and Northern areas. The study also emphasizes the importance of revitalizing actualistic taphonomy, strengthening conservation paleobiology, and increasing research in paleobotany and micropaleontology. Moreover, integrating robust stratigraphic and geochronological frameworks is essential for advancing taphonomic studies and Brazilian paleontology more broadly. These findings provide a comprehensive perspective on the evolution, current status, and future directions of taphonomic research in Brazil.

Keywords: Brazilian paleontology, fossil assemblages, research history, biostratigraphy, fossilization.

INTRODUCTION

Taphonomy, the branch of paleontology concerned with the processes of preservation and fossilization of organisms, plays a critical role in interpreting the fossil record and reconstructing past environments (Behrensmeyer & Kidwell, 1985; Lyman, 1994). In Brazil, despite its vast geological and paleobiological diversity, taphonomic research only began to emerge with greater consistency in the late 1980s. Early milestones include pioneering dissertations and the first scientific publications that highlighted the relevance of integrating taphonomic analysis into paleontological research (Bergqvist, 1989; Martins-Neto, 1990; Schultz *et al.*, 1990; Holz & Barberena, 1994).

Over the following decades, there has been a steady increase in interest and scientific output related to taphonomy in Brazil, reflecting the maturation of the field at the national level (Simões & Ghilardi, 2000; Kotzian & Simões, 2006; Bergqvist *et al.*, 2011; Moutinho *et al.*, 2016; Iniesto *et al.*, 2021). However, despite investigations of taphonomy in Brazil in specific contexts, as reviews about actualistic taphonomy (Ritter *et al.*, 2016; De Francesco *et al.*, 2025) or cave vertebrates taphonomy (Vasconcelos *et al.*, 2018), the historical development of Brazilian taphonomic research has yet to be systematically analyzed broadly in terms of its temporal and spatial trends, preferred geological contexts, institutional affiliations, and the relationship between scientific publications and postgraduate training. This lack of a consolidated bibliometric perspective limits our understanding of the field's growth, research priorities, and emerging gaps.

This study aims to address that gap by providing a comprehensive bibliometric analysis of Brazilian scientific production in taphonomy,

including where it began, the development of the field, and where and how it occurred; the evaluation of human resource formation in the field and the scientific production; and how it can evolve. To do so, data were collected from a combination of international and national databases, including Scopus, Web of Science, Google Scholar, and the CAPES Theses and Dissertations Catalog. Advanced data science techniques, natural language processing (NLP), and statistical modeling were applied to extract and analyze key trends. Beyond the quantitative assessment, the research also considers qualitative aspects, including the discipline's historical trajectory, key scientific events, and the roles of leading researchers and institutions in shaping the field.

In this research, we investigate the historical evolution of the field, both qualitatively and quantitatively, significant international influences, and pioneering researchers in Brazilian taphonomy. By identifying production patterns, thematic focuses, and the evolution of research over time, this study contributes to consolidating the discipline of taphonomy in Brazil. Furthermore, it provides a foundation for future research policies, collaborative networks, and the identification of underexplored areas within the field, reinforcing its scientific and educational importance in both national and international contexts (Abdullah *et al.*, 2023).

MATERIAL AND METHODS

To conduct a bibliometric analysis of Brazilian publications on taphonomy, we collected articles and documents from the following databases: Scopus, Web of Science, Google Scholar, and Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES) Catalog of Theses and Dissertations.



Data from Scopus and Web of Science were directly extracted from their interfaces, accessed through the website of the CAPES, to get access. To extract data from Google Scholar, the web scraping technique was employed (Kumaresan & Ramanujam, 2016) using Selenium and BeautifulSoup.

However, despite the more extensive coverage than Scopus or Web of Science (Harzing & Alakangas, 2016), to construct the Google dataset, there are some limitations that need to be taken into account regarding access barriers, result sets, and the final effort to construct the dataset. Google Scholar has ways to prevent being overloaded by robots through the triggering of reverse Turing tests, so the scraping needs to be cautious and respectful to be completed. Also, the result sets return only 10 results per page, and web pages are frequently updated, resulting in the modification of the source code and in the way the objects (abstracts, titles, authors, pagination buttons, and search bar) in the page are gathered in programming language, so the scraping strategy also needs to handle the pagination, page objects, and the speed of the gathering concerning the first point. The generated dataset is still poorly structured for a ready-to-go analysis, so, at the end, a combination of heavy manual work and automated strategies is still needed to finish (Meschenmoser *et al.*, 2016).

The retrieved data were merged with Scopus and Web of Science data coverage into one CSV file using Pandas (The Pandas Development Team, 2024), other information that was not in the Google original file was filed manually. Data collection was completed in December 2024.

Data from Capes were collected from the open database of the CAPES Catalog of Theses and Dissertations (<https://dadosabertos.capes.gov.br/>), including all concluded dissertations and theses on the topic available to date, 2022. The data was downloaded into chunks of Excel files (.xlsx), then we used Regular Expressions to filter the rows of interest in each file with the same descriptors used to search for peer-reviewed databases. Pandas was employed to write a CSV file from all the filtered chunks. Furthermore, we conducted a literature review and examined the curricula of leading researchers in the field of taphonomy.

To identify relevant data, we craft the broadest taphonomic-related keyword set in order to capture the majority of the related documents. The keyword set was the following combination of descriptors: “tafonomia OR tafonomica OR tafofacies OR tafonomico OR bioestratinomia OR bioestratinomica OR bioestratinomico OR fossildiagênese OR fossildiagenéticos OR fossildiagenéticas AND brasil”. This same combination was translated into English and Spanish to expand the search scope. Documents that do not have the combination of keywords in title, keywords, or abstract were erased, for scientific articles, documents that have not gone through peer review, and for CAPES data that was not a thesis or a dissertation were also erased.

With the two CSV files, the cleaning and analysis proceeded. was performed using Pandas, Regex, and NumPy (Harris *et al.*, 2020) to handle table values, duplicates, missing values, data conversion, lowercase, whitespace removal, extracting terms, and mathematical operations. Geographic data was processed using GeoPandas and Shapely for retrieval, generation, and

geometric manipulation. We also used Matplotlib and Seaborn for data visualization, generating a series of visualizations, to explore the dataset.

Along with the general visualizations, a forecast was applied employing Prophet, using the annual publication counts. In the library, the Laplace prior was used implicitly by maximum a posteriori estimation (MAP) to regularize the trend model, identifying the change points and estimating the rate changes. Thus, the historical trend pattern was extrapolated to generate a forecast extending 10 years into the future. The uncertainty intervals were calculated using Monte Carlo simulation, calculating 1000 possible future trends based on the MAP trend fitted before, then generating a 80% confidence interval for these possible trends (Taylor & Letham, 2018).

In addition to forecast trends, annual counts of articles and theses/dissertations were analyzed to assess the relationship between their growth rates. We performed an ordinary least squares (OLS) regression using the number of new post-graduation documents per year against annual change of article counts. We also investigated the strength of this association through a Pearson correlation coefficient. The articles dataset was analyzed alongside theses and dissertations, leveraging up to 2022.

Along with statistical inference, Natural Language Processing (NLP) was employed. WordCloud was used for data exploration and Topic Model (Blei *et al.*, 2010) based on the Latent Dirichlet Allocation (LDA) algorithm (Blei *et al.*, 2003). We specifically used MALLET's LDA 2.0.8, which uses collapsed Gibbs sampling with automatic optimization of model hyperparameters (McCallum, 2002). To perform topic modelling we follow a strict succession of steps, first we take the abstract and year columns to analyze, stop words from English and Portuguese were handled with the Natural Language Toolkit (Bird *et al.*, 2009), being erased from the dataset, the remaining words were tokenized and lemmatized (Yogish *et al.*, 2019), and then LDA algorithm was applied with a number of topics defined by Pointwise Mutual Information (Cruys, 2011), UMass (Rosner *et al.*, 2014), *c_uci* (UCI PMI) (Newman *et al.*, 2010), *c_npmi* (Normalized PMI) (Bouma, 2009) and *c_v* (CV) (Röder *et al.*, 2015) coherence methods, and our judgement (Vaid *et al.*, 2023) to determine the optimal number of topics, the exact number was picked considering the confluence between the five methods, taking advantage of each method strength. Matplotlib was used once again to visualize both the topics and the coherence thresholds. All analyses were performed in Python, v. 3.8.16.

RESULTS

Historical milestones of the Brazilian taphonomy

One of the earliest abstracts to be published in event proceedings was “A importância da Tafonomia para o estudo de vertebrados fósseis”, by Michael Holz and Mário Costa Barberena, presented at the “IV Simpósio Sul-Brasileiro de Geologia” in Porto Alegre/RS in 1989 and published in *Acta Geologica Leopoldensia*, vol. XII (Holz & Barberena, 1989).

In the same year, the first Master's dissertation addressing the topic was completed: *Mamíferos pleistocênicos do Estado da Paraíba, depositados no Museu Nacional, Rio de Janeiro*, authored by Lílian Paglarelli Bergqvist under the supervision of Fausto Luiz de Souza Cunha, for the Master's in Biological Sciences (Zoology) at the Federal University of Rio de Janeiro (UFRJ) (Bergqvist, 1989).

The first scientific publication in taphonomy was released in December 1990 in the journal *Ciência e Natura*. The article, titled *Taphonomy of Permo-Triassic Vertebrates: Diagenesis as a Factor of Morphological Alteration*, was authored by Cesar L. Schultz, Michael Holz, and Natálio Gamermann (Schultz *et al.*, 1990). It highlighted the significance of taphonomic analysis in studying Permo-Triassic paleovertebrates and was the first to explicitly recognize the importance of integrating taphonomic principles into future research.

In 1991, Michael Holz completed his Master's dissertation in Geosciences titled *Tafonomia de vertebrados do Triássico no RS: padrões de morte, transporte e soterramento da paleoherpetofauna*, under the supervision of Mário Costa Barberena at the Federal University of Rio Grande do Sul (UFRGS) (Holz, 1991). That same year, several abstracts were presented at the XII Brazilian Congress of Paleontology in São Paulo. Lílian Paglarelli Bergqvist, Cástor Cartelle, and Ramses Capilla presented a comparative, taphonomic, and paleoenvironmental study of Pleistocene mammals from Taperoá/PB, Campina Grande/PB, and Itapipoca/CE (Bergqvist *et al.*, 1991). Michael Holz and Mário Costa Barberena discussed the taphonomy of the Triassic sequence in Rio Grande do Sul, focusing on mechanisms of death and preservation of the paleoherpetofauna (Holz & Barberena, 1991). Also presented was a study by M. Costa Jr., Michael Holz, and Cesar Schultz on the application of Mössbauer spectroscopy to the diagenetic study of the Southern Brazilian Triassic paleoherpetofauna (Costa-Júnior *et al.*, 1991).

In 1993, at the XIII Brazilian Congress of Paleontology in São Leopoldo, RS, several important taphonomic works were featured. Torello-de-Mello & Simões (1993) examined the taphonomic characteristics of the *Pinzonella illusa* Reed assemblage from the Corumbataí Formation (Neopermian) in the Paraná Basin. Simões & Rocha-Campos (1993) presented on the taphonomic history of Late Paleozoic shell beds in the Paraná Basin. Luiz Eduardo Anelli, Simões, and Francisco Pinheiro Lima Filho analyzed the taphonomy of bivalve assemblages from the Mocambo Limestone, Piauí Formation (Late Carboniferous), in the Parnaíba Basin (Anelli *et al.*, 1993). Michael Holz contributed with a preliminary model for the taphonomy of vertebrates from the Sanga do Cabral unit (Lower Triassic) in Rio Grande do Sul (Holz, 1993). Holz & Schultz (1993) also presented on the diagnosis and classification of Triassic tetrapods, emphasizing the role of diagenesis in bone morphology.

In 1994, Fernanda Torello de Melo completed her undergraduate thesis in Biological Sciences, focusing on the biostratigraphic and sedimentological characteristics of *Pinzonella illusa* and *Pinzonella neotropica* assemblages from the Corumbataí Formation (Permian), under the supervision of Marcello Guimarães Simões at UNESP

(Torello-de-Mello, 1994). That same year, Costa Jr., Holz, and Schultz published a study on the Mössbauer effect and diagenesis of the Southern Brazilian Triassic paleoherpetofauna in *Hyperfine Interactions* (Costa-Júnior *et al.*, 1994). Additionally, Holz & Barberena (1994) published the article *Taphonomy of the south Brazilian Triassic paleoherpetofauna: pattern of death, transport and burial in Palaeogeography, Palaeoclimatology, Palaeoecology*.

In 1997, a comparative, taphonomic, and paleoenvironmental study on Pleistocene mammal faunas from Itapipoca (CE), Taperoá (PB), and Campina Grande (PB) was published by Lílian Paglarelli Bergqvist, Márcia Gomide, Cástor Cartelle, and Ramsés Capilla in *Geociências* (Bergqvist *et al.*, 1997).

In 2000, a book on Paleontology by Ismar de Souza Carvalho (Carvalho, 2000) was released, which bear the first chapter dedicated to taphonomy in Portuguese language. In 2002, Michael Holz and Marcello G. Simões published *Elementos Fundamentais da Tafonomia*, a foundational text in the field (Holz & Simões, 2002). That same year, an article titled *Feições tafonômicas observadas em fósseis pleistocênicos do Rio Grande do Norte* was published in the *Revista de Geologia*, authored by Maria de Fátima Cavalcante Ferreira dos Santos, Lílian Paglarelli Bergqvist, Francisco Pinheiro Lima Filho, and Marcela Marques Vieira Pereira (Santos *et al.*, 2002). Several articles and abstracts have been published since then on Brazilian taphonomy, which are quantitatively presented in the following topics of this article.

In 2016, the *Manifesto of the South American School of (actualistic) Taphonomy* was published by Matias do Nascimento Ritter, Claudio G. de Francesco, Fernando Erthal, Gabriela S. Hassan, Eleonor Tietze, and Sergio A. Martínez in *Palaios* (Ritter *et al.*, 2016). In 2018, the *Taphonomy and Stratigraphic Paleobiology Research Group* was created under the coordination of Hermínio Ismael de Araújo-Júnior at UERJ, which is currently associated with the international *Taphonomy Working Group*.

Another important milestone in the history of taphonomy in Brazil was the foundation of the Brazilian Symposium on Taphonomy, by Hermínio Ismael de Araújo-Júnior and Marcello Guimarães Simões. The I Brazilian Symposium on Taphonomy was held in 2019 during the XXVI Brazilian Congress of Paleontology in Uberlândia, Minas Gerais, and featured 26 published abstracts. The second edition of the II Brazilian Symposium on Taphonomy took place in Porto Alegre, Rio Grande do Sul, in 2023, with 36 abstracts. The third edition, held in Campinas, São Paulo, in 2025, received 62 abstracts. The progressive increase in the number of published abstracts clearly demonstrates a growing interest in the field.

Quantitative analysis of Brazilian research in Taphonomy

Distribution of scientific articles over the years

The final dataset included 391 records encompassing articles published between 1990 and 2024. Following the publication of the first article in 1990, no further publications occurred until 1994. Between 1990 and 2000, the number of annual publications in scientific journals showed modest fluctuations, ranging from zero to six articles per year. This period was marked by relatively low and irregular activity, with some years with no publications.

From 2001 to 2010, a gradual increase in scientific output can be observed. During this decade, the number of articles published per year generally ranged between one and thirteen, indicating a steady rise in academic interest and production for the field.

In 2011, the growth became more pronounced. In 2013, the number of publications reached approximately 25, followed by a drop in 2014 to around eight articles. However, this decline is temporary, as the following years show a recovery in the upward trend.

The number of articles continues to grow consistently, reaching a peak of 32 publications in 2024. Overall, a growing trend in the number of articles published in scientific journals over time can be noted. Although there are occasional fluctuations, especially in the early years, the dominant pattern is one of continuous expansion, particularly from the second half of the 2000s onward. (Figure 1). And it is expected that the number of publications will continue to grow substantially (Figure 2).

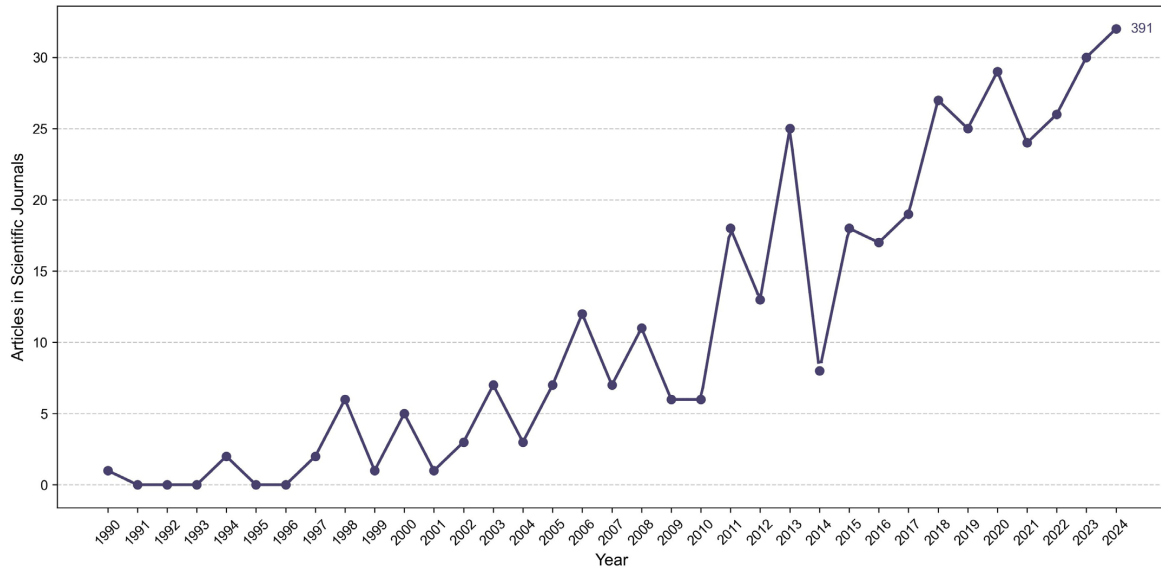


Figure 1. Chronological development of the scientific research on taphonomy in Brazil per year.

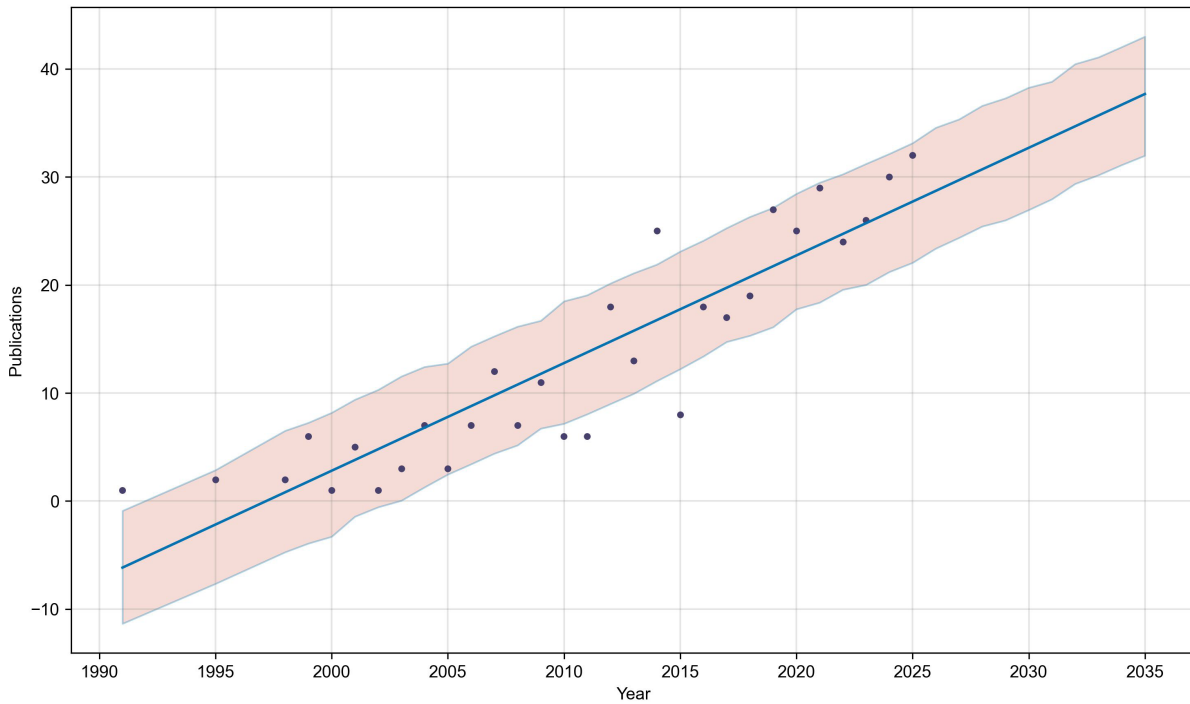


Figure 2. Prophet forecast analysis until 2035.

Geographic distribution of deposits analyzed in taphonomic studies

The geographical distribution of deposits analyzed for taphonomic features, as depicted in the distribution map of Figure 3, reveals a concentration of research efforts in the Southern, Northeastern, and Southeastern regions of Brazil. The southern region exhibits a strong focus on invertebrate taphonomy, with states such as Rio Grande do Sul and Paraná contributing significantly. In the Northeast, Ceará stands out because of extensive studies within the Araripe Basin and investigations of Quaternary deposits. Furthermore, Bahia and Minas Gerais are recognized for their contributions to the understanding of Quaternary Taphonomy. Conversely, we observed the fewest taphonomic studies in the Northern region.

Geological formations in taphonomic studies

Considering the most analyzed geological formations in taphonomic studies, we observe a higher frequency of research on the Crato and Ponta Grossa Formations (Figure 4).

Regarding the most studied geological periods in Brazilian taphonomic research, most studies have been conducted on Quaternary fossil assemblages, followed by the Cretaceous ones (Figure 5).

Scientific journals and keywords

Among the journals that most frequently publish Brazilian taphonomic studies, the majority were published in the “Journal of South American Earth Sciences”, followed by the “Revista Brasileira de Paleontologia” and “Palaeogeography, Palaeoclimatology, Palaeoecology” (Figure 6). Regarding the language distribution of published works, English predominated, accounting for 70.1% of publications, while Portuguese accounted for 29.7%. Only a small proportion (0.3%) were Spanish.

The study of the most common keywords in the titles of articles showed that terms like “Brazil/Brasil”, “Taphonomy” and “Cretaceous” appear frequently (Figure 7). We employed a word cloud because of its significance in identifying the most frequent terms and focus areas within textual data (Chen *et al.*, 2020).

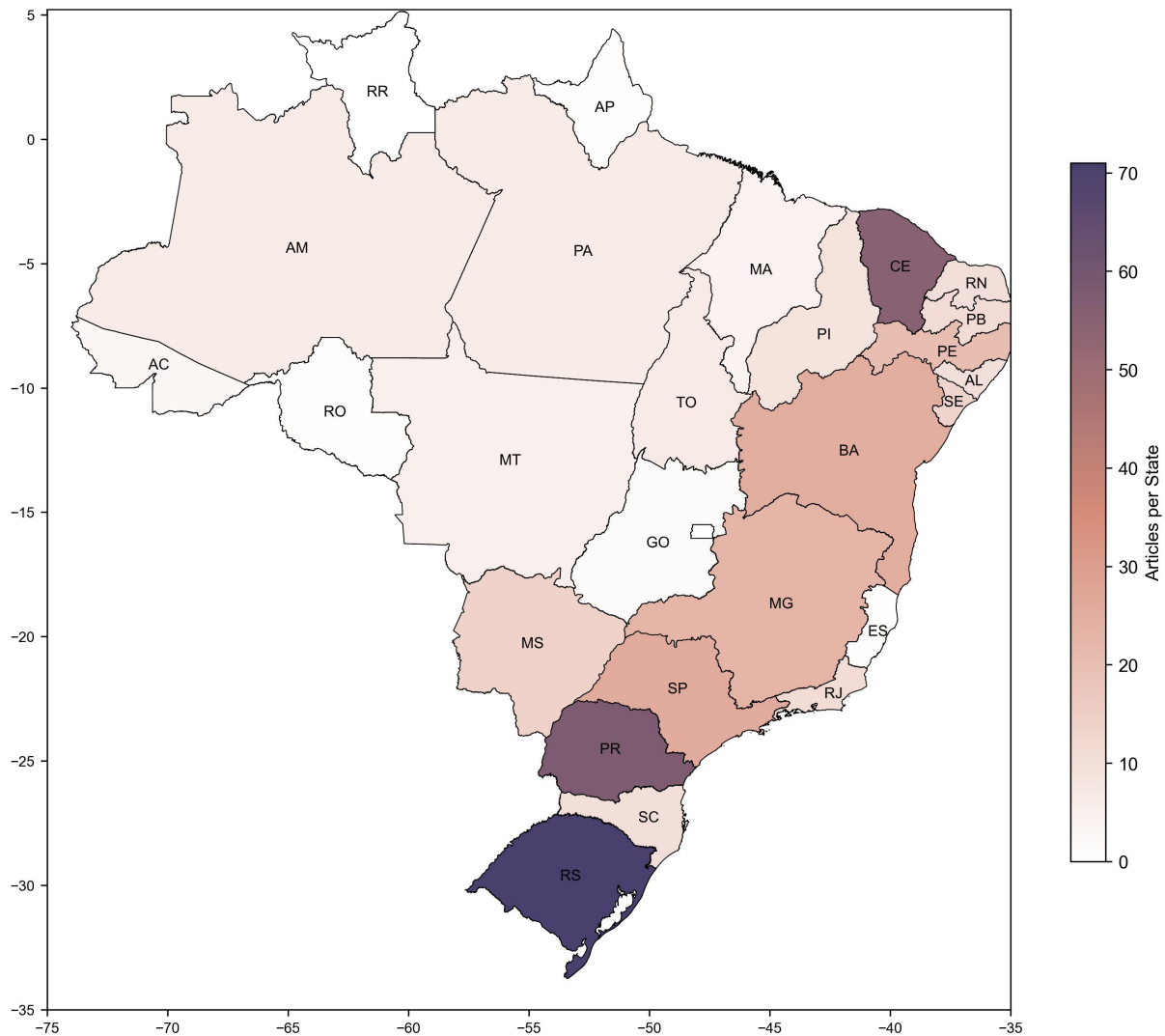


Figure 3. Geographic distribution representing the frequency of the number of studies in taphonomy for Brazilian states.

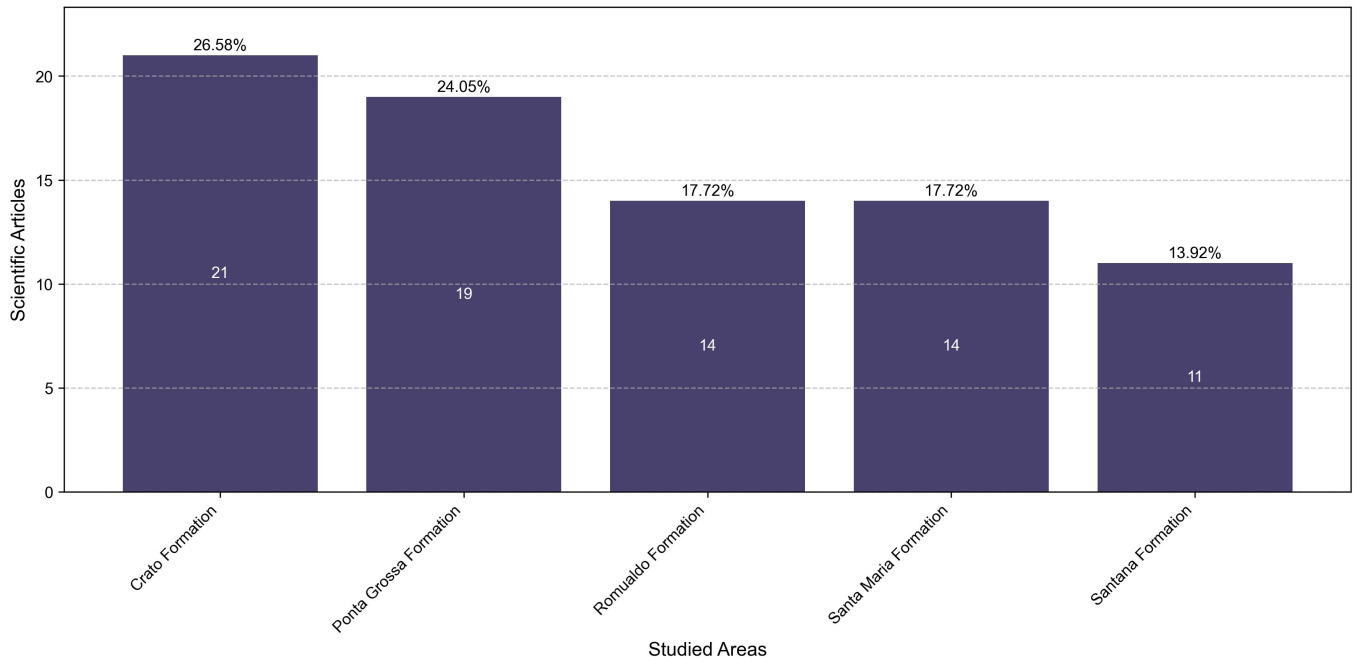


Figure 4. Frequency of scientific studies considering the geological formations analyzed.

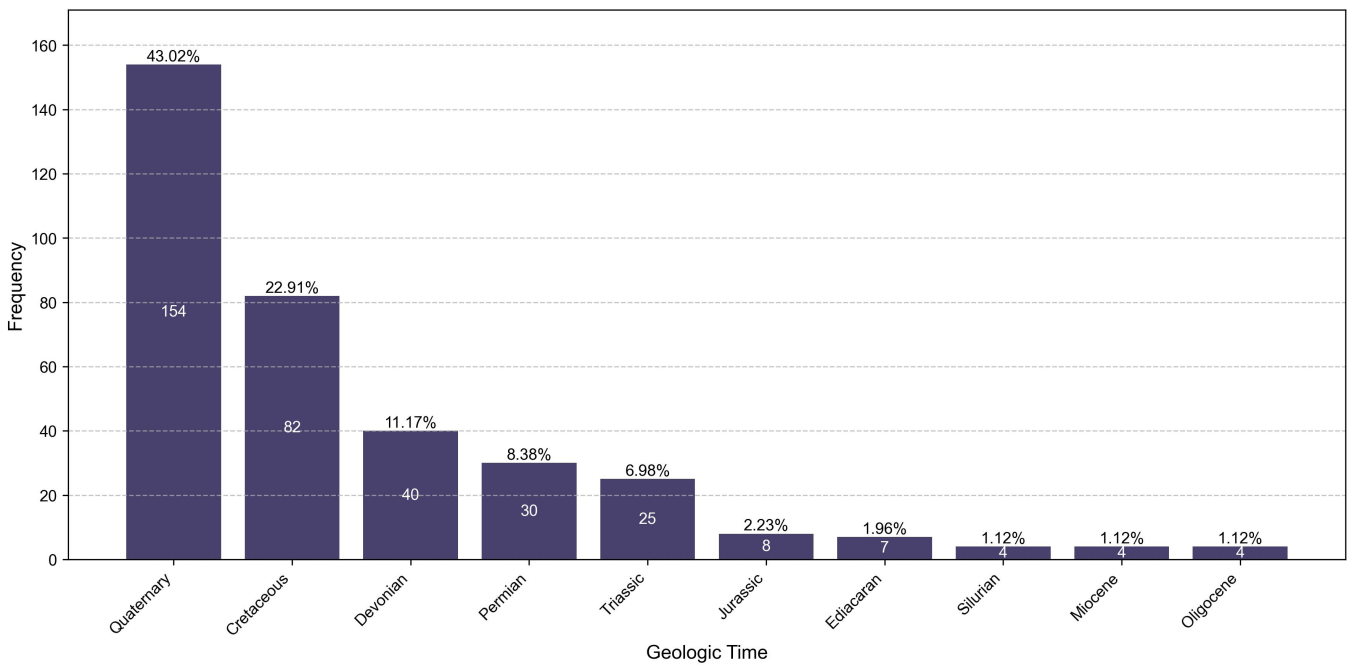


Figure 5. Frequency of scientific studies considering geological periods.

Topic modeling analysis

The topic modeling analysis (Figure 8) was made by observing the topic’s evolution in the thematic landscape on the works’ abstracts. Five topics (Table 1) were created based on coherence indexes (PMI Coherence: 0.753, UMass Coherence: -1.266, c_v: 0.672, c_{npmi}: 0.037, c_{uci}: -1.350) (Table 2). All five topics were clearly separated into meaningful ones.

Topic 1 (study of marine shell facies) has the second highest representation in general, increasing punctually from 1995 to 2005 and from 2010 to 2025. Topic 2 (study of bone assemblage) has the highest representation in the analysis, steadily increasing along the years and peaking in interest between 2015 and 2025 with the highest topic probability. The other topics are less represented, as topic 3 (mammal fossil deposit analysis) is

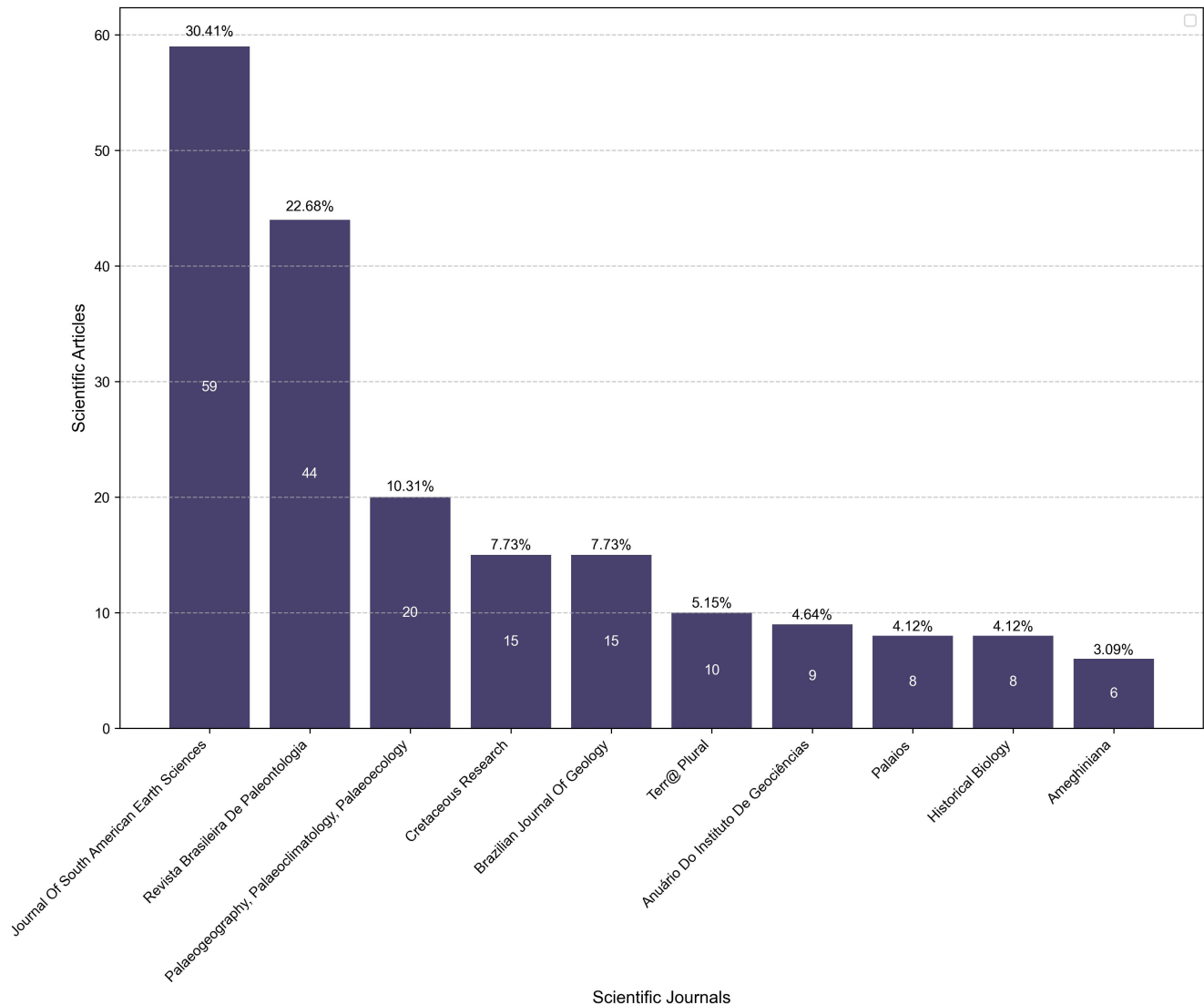


Figure 6. Frequency of taphonomy articles in leading scientific journals.

present across almost all years, being found most in documents between 1990 and 2015, with the highest representation between 2005 and 2010; a gap occurs from 2015 to 2020, and it surges again in 2020. Topic 4 (study of preservation of fish specimens) is represented across all years, with low representation, peaking between 1995 and 2000, then abruptly decreasing in 2000, and slowly decaying until 2025. Topic 5 (taphonomic features of shell sediments) has the highest peak across all topics from 1995 to 2000, then abruptly decreases in interest, returns in 2000, increases again from 2005 to 2010, and gradually receives less interest until it reaches its lowest point between 2020 and 2025.

Dissertations and theses

Between 1989 and 2022, we observed 199 documents, including 59 theses, 139 academic master's dissertations, and one professional master's dissertation (Figure 9). A high variation over the time is observed in the number of these

documents, however, the number of trained researchers in the field of taphonomy is expected to slightly grow in the coming years (Figure 10). These documents were mostly produced in graduate programs from the Southeast region, followed by the Northeast (Figure 11). The researchers were, for the most part, trained in graduate programs in the field of geosciences, followed by zoology (Figure 12).

The main geological formations studied in theses and dissertations were Santana (Araripe Basin), Ponta Grossa (Paraná Basin), and Adamantina (Bauru Basin), followed by Solimões (Solimões Basin), Santa Maria (Paraná Basin), and Irati (Paraná Basin) (Figure 13).

The main universities that contributed to the training of researchers in taphonomy until 2002 were the Universidade Federal do Rio Grande do Sul (UFRGS), the Universidade de São Paulo (USP), and the Universidade Federal do Rio de Janeiro (UFRJ) (Figure 14).

Table 1. Topic modeling top words and topic title for articles.

Topic	Top words	Topic synthesis
Topic 1	shell basin facies fossil condition marine analysis brazil sedimentary study	Study of marine shell facies
Topic 2	fossil bone deposit assemblage remains record study specimen late group	Study of bone assemblage
Topic 3	fósseis ossos material mamíferos brasil análise restos durante depósito soterramento	mammal fossil deposit analysis
Topic 4	fossil preservation specimen preserved brazil early microbial fish mat nov	Study of preservation of fish specimens
Topic 5	formação concha tafonômicas bacia características sedimentos sul estudo grossa tempestades	Taphonomic features of shell sediments

Table 2. Coherence metrics values for article corpus (2–50 topics).

Number of Topics	PMI	UMass	c_v	c_npmi	c_uci
2	0.354	-1.305	0.594	0.058	-1.628
3	0.189	-1.297	0.589	0.056	-1.684
4	0.554	-1.199	0.638	0.075	-1.384
5	0.753	-1.266	0.672	0.037	-1.350
6	-0.227	-1.460	0.583	0.0002	-2.375
7	-0.065	-1.418	0.617	-0.013	-2.384
8	-0.870	-1.501	0.615	-0.060	-3.108
9	-1.461	-1.561	0.559	-0.094	-3.721
10	-1.250	-1.463	0.572	-0.076	-3.564
11	-1.747	-1.661	0.532	-0.104	-4.099
12	-0.702	-1.550	0.604	-0.078	-3.233
13	-2.460	-1.533	0.543	-0.126	-4.748
14	-1.824	-1.527	0.544	-0.102	-4.177
15	-2.615	-1.494	0.530	-0.102	-4.788

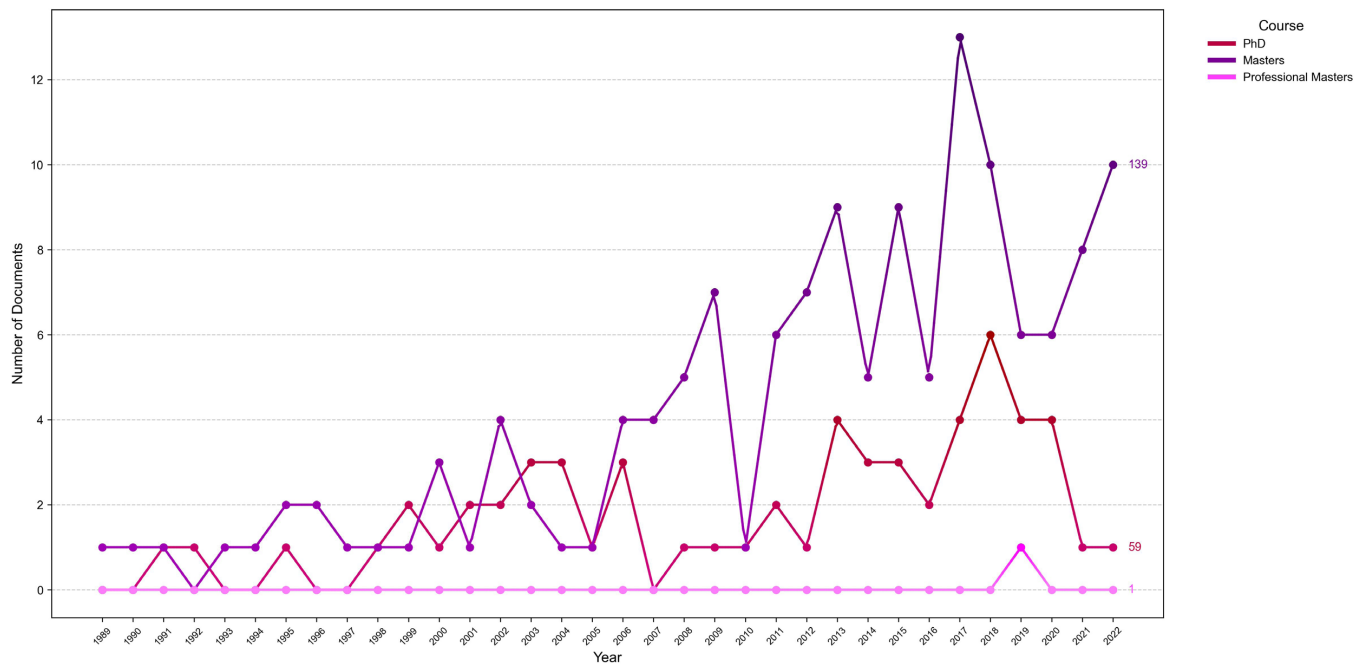


Figure 9. Chronological development of the theses and dissertations on taphonomy in Brazil per year.

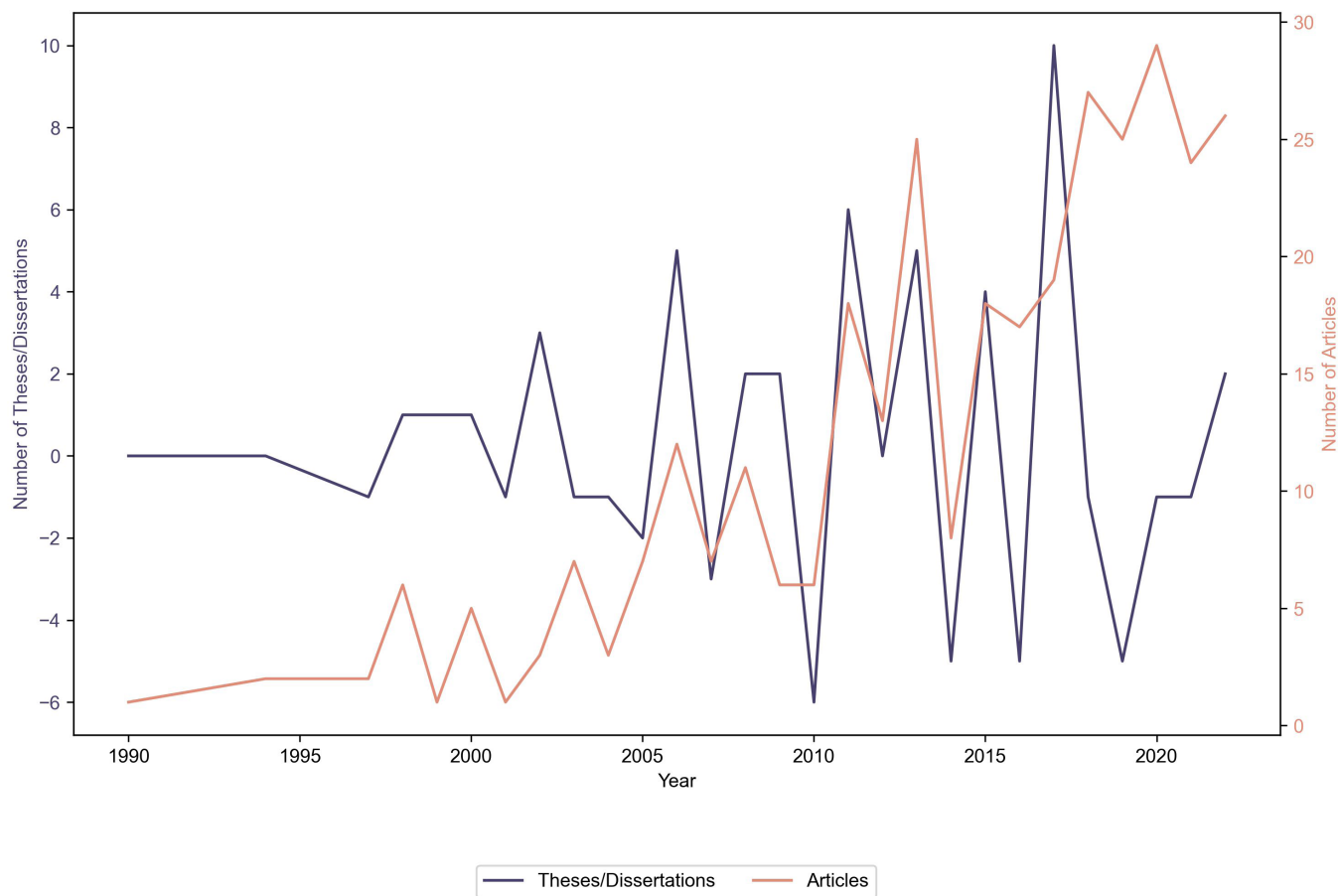


Figure 10. Theses, dissertations and scientific articles growing along the three decades.

Table 3. Coherence metrics values for dissertations and thesis corpus (2–50 topics).

Number of Topics	PMI	UMass	c_v	c_npmi	c_uci
2	0.155	-1.198	0.391	-0.012	-1.259
3	-0.512	-1.384	0.418	-0.039	-2.152
4	-0.904	-1.449	0.390	-0.077	-2.598
5	-0.514	-1.382	0.410	-0.106	-2.229
6	-2.086	-1.368	0.414	-0.103	-3.778
7	-1.1733	-1.384	0.472	-0.115	-3.0009
8	-3.235	-1.501	0.372	-0.151	-4.934
9	-2.442	-1.309	0.464	-0.115	-4.218
10	-1.043	-1.353	0.494	-0.090	-2.999
11	-3.179	-1.440	0.414	-0.185	-4.957
12	-1.951	-1.358	0.487	-0.154	-4.042
13	-1.744	-1.405	0.465	-0.141	-3.759
14	-3.829	-1.372	0.463	-0.181	-5.623
15	-2.976	-1.427	0.443	-0.163	-4.952

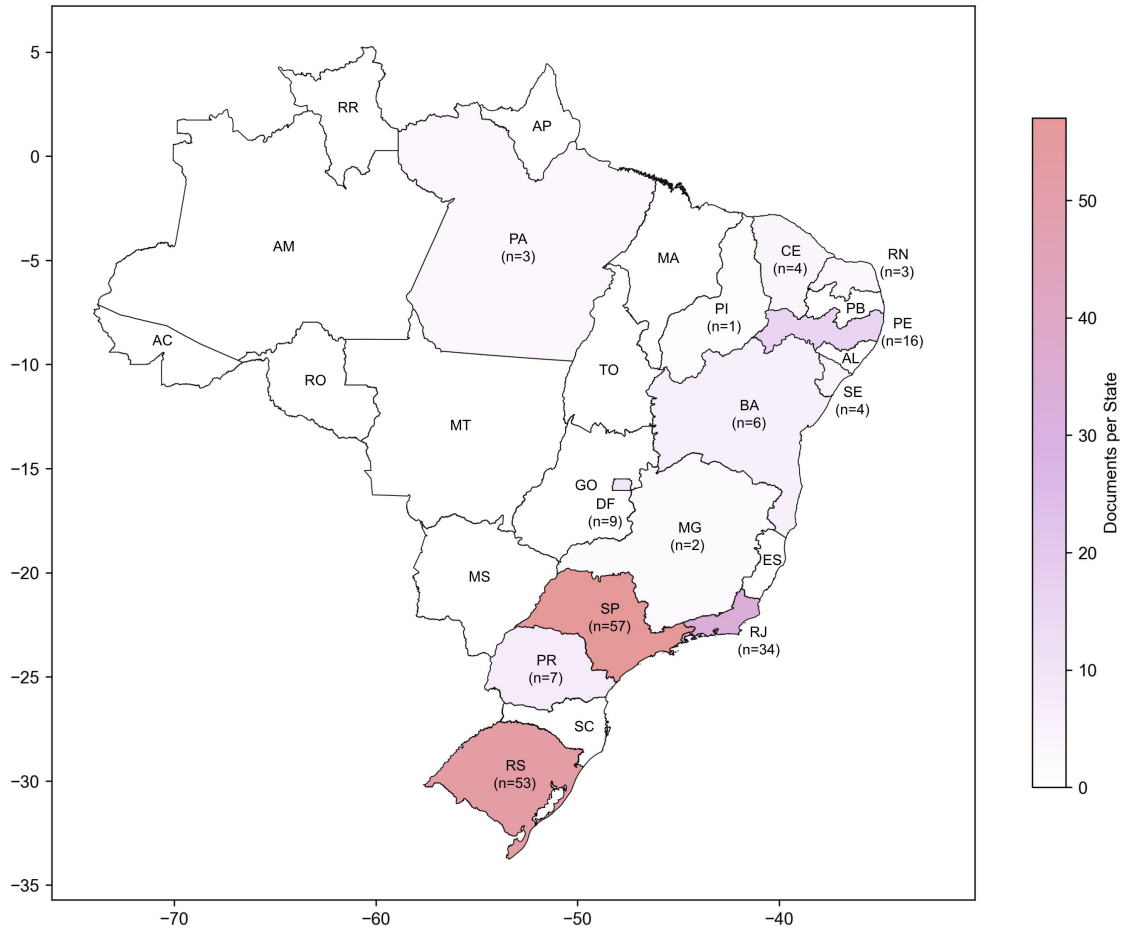


Figure 11. Geographic distribution of graduate programs that produced theses and dissertations on taphonomy.

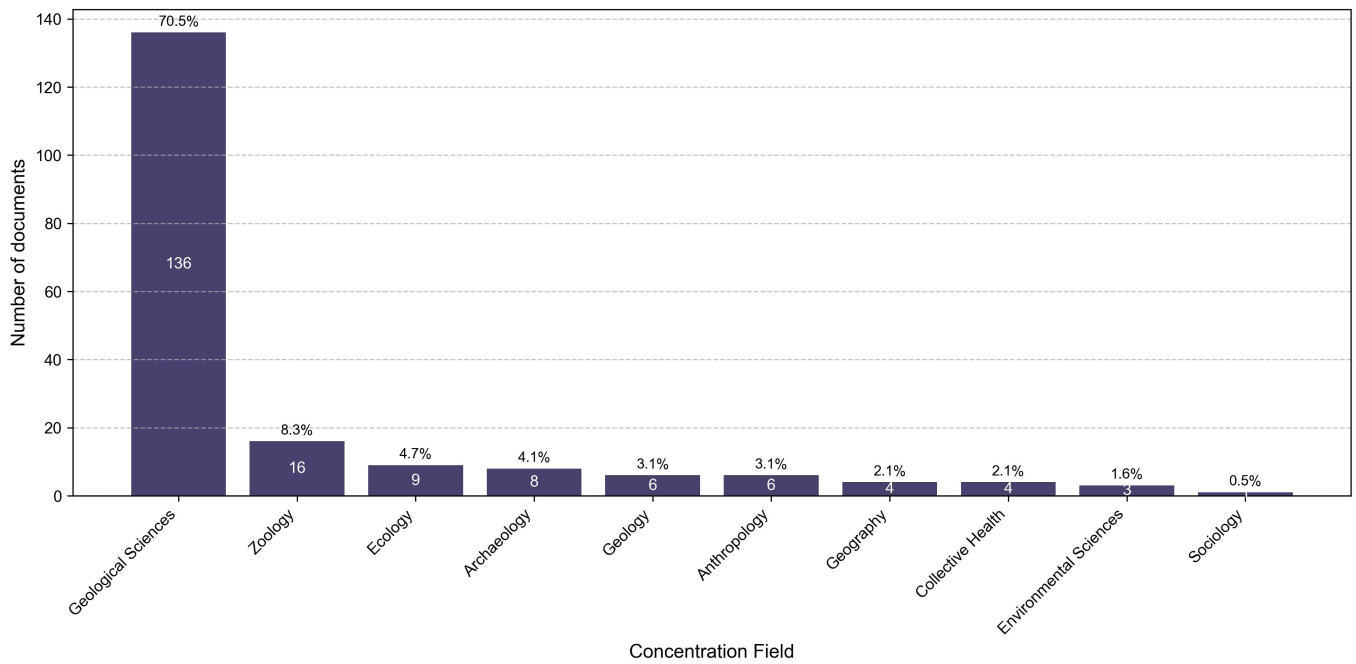


Figure 12. Frequency of theses and dissertations considering the field of graduate programs in Brazil.

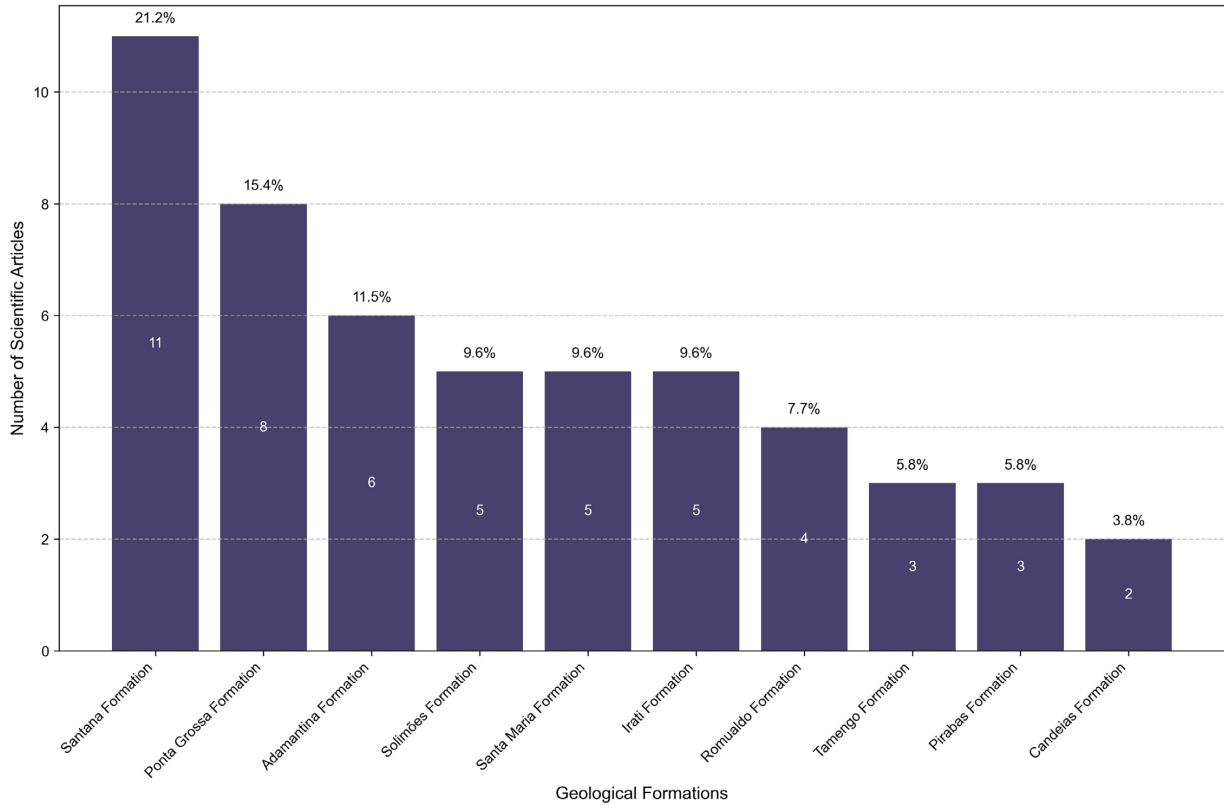


Figure 13. Geographic distribution of theses and dissertations considering the geological formations analyzed.

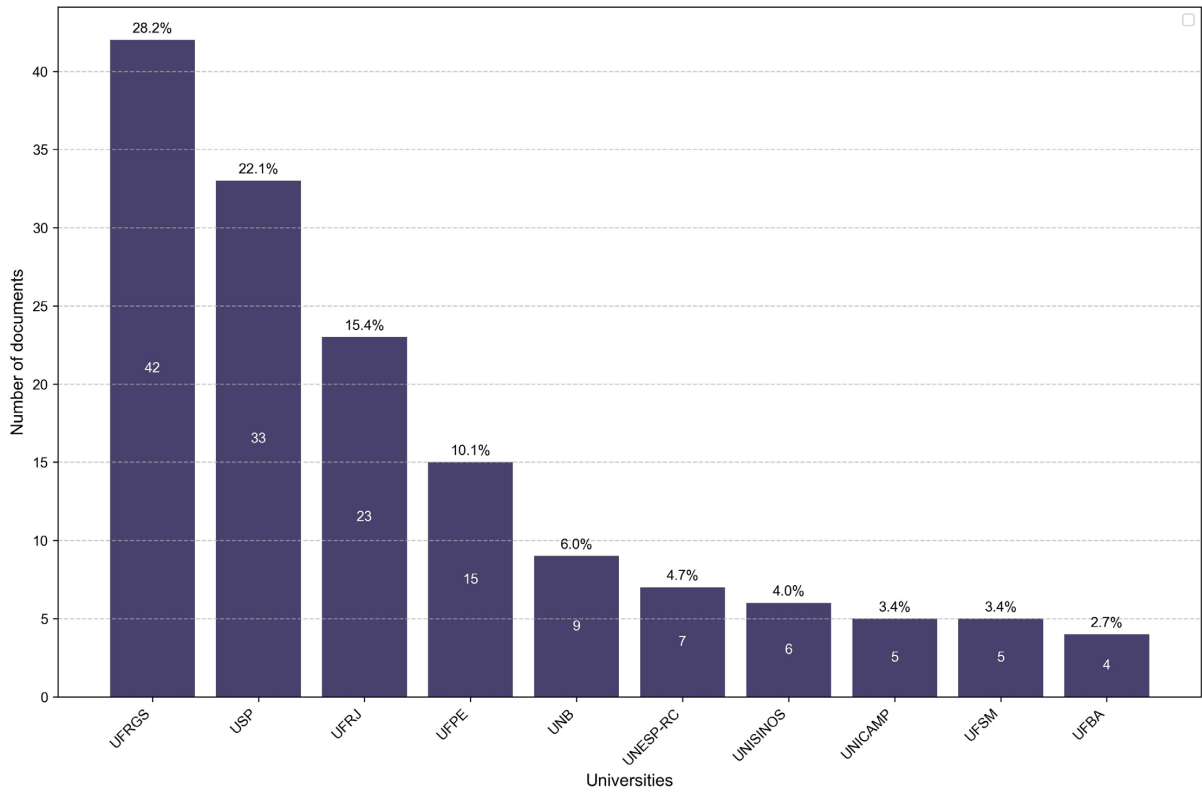


Figure 14. Frequency of the leading universities with defended theses and dissertations on taphonomy-related topics.

The phase of consolidation and high production (2020s) reflects the outcomes of the institutionalization established in the preceding decade. The continued success of the Brazilian Symposium on Taphonomy, evidenced by the progressive increase in abstracts, confirms an engaged scientific community. The quantitative pattern demonstrates a growth trend, resulting in more than 30 publications in 2024, showing a high level of research activity.

Despite the steady increase in scientific output, and a moderate positive correlation between the number of trained researchers and article publications ($r = 0.54$, $p = 0.003$), (Figure 10). The regression model significantly explained the change in article ($F(1, 25) = 10.31$, $p = 0.003$) but indicated a lower explanatory power ($R^2 = 0.292$), suggesting that other factors, such as collaborative networks, funding, and international partnerships, also play significant roles in driving publication rates. The distribution of studies across Brazil further reflects regional asymmetries, with the southern, southeastern, and northeastern regions concentrating most research efforts, particularly in well-exposed and fossiliferous formations like the Crato, Ponta Grossa, and Santana.

The prevalence of English-language publications reflects the global integration of Brazilian research, while the continued use of Portuguese underscores the importance of local dissemination and education. The prominence of journals such as *Journal of South American Earth Sciences* and *Revista Brasileira de Paleontologia* highlights both international visibility and strong regional engagement.

The keyword analyses reinforce the central themes of Brazilian taphonomic research, its focus on vertebrates, basins, and specific stratigraphic formations. These findings are consistent with the country's paleogeographic diversity and the historical emphasis on faunal and depositional contexts.

The topic modeling analysis of abstracts revealed distinct clusters for scientific articles. The most representative topics emerged from general themes related to taphonomy. Specifically, Topic 1, about shell taphonomy study, is inconsistently represented, its prevalence alternates with Topic 5, which addressed the same theme but in Portuguese. This shift in language suggests a transitional period in publication trends, with the surge in Portuguese-language articles in 1990, decreasing in 1995, appearing again in 2005 and gradually decreasing in subsequent years before a subsequent resurgence in English-language publications in recent years. This topic can be represented with works like Simões *et al.* (2005, 2009).

Topic 2 was a recurring and dominant theme throughout the entire study period, representing general studies with vertebrates in English, slightly overlapping with Topic 3 that wrap the studies of fossil mammals. Vertebrates and mammals specifically were present with works like Bergqvist *et al.* (1997) and Lopes *et al.* (2001), surging again with works like Auler *et al.* (2006), Silva *et al.* (2010), Araújo-Júnior *et al.* (2013, 2015), and Lopes & Ferigolo (2015), and later with Mothe *et al.* (2020).

Topic 4 is the most stable topic across all years, being represented from 1990 until 2025 consistently but moderately, represented by works such as Saldanha *et al.* (2023), Viana and Richter (1998), Fürsich *et al.* (2019), the first work from the Paraná basin, and the other two from the Araripe Basin.

In general, the interest in the themes and looking into how the articles evolved over time, language being one of the most evident, shifting the topics. The themes quickly become more widely distributed in interest, with topic 2 showing the highest dominance, indicating a strong interest in vertebrates. It's notable also in the other topics that there is an even distribution of interest for the themes between 2005 to 2015 and then a discrepancy 2015 onwards.

For theses and dissertations, we cannot find coherence in the topics. This can occur due to many factors, including a myriad of different themes in these documents' corpus and also the limitation of the analysis using only abstracts, instead of the full texts, preventing a separation of clear topics.

Brazilian taphonomy shares several conceptual and methodological foundations with taphonomic research developed worldwide, but it also exhibits distinctive historical, geographic, and thematic characteristics. Globally, taphonomy consolidated earlier, particularly from the 1970s onward, with strong traditions in North America and Europe emphasizing actualistic studies, quantitative models, experimental approaches, and broad integration with paleoecology, sedimentology, and stratigraphy. In contrast, Brazilian taphonomy emerged later, gaining consistency only in the late 1980s, and initially developed through isolated pioneering efforts before achieving institutional consolidation in the 2000s. While international research displays a more even distribution across regions, environments, and organismal groups, Brazilian taphonomic studies remain geographically concentrated in the Southern, Southeastern, and Northeastern regions and thematically focused on vertebrates, especially Quaternary mammals, and Cretaceous Konservat-Lagerstätten, such as those of the Araripe Basin. Nevertheless, Brazil stands out globally for its exceptional fossil deposits, which have enabled high-impact contributions to the understanding of exceptional preservation, microbial mediation, and conservation paleobiology. In recent decades, Brazilian taphonomy has increasingly aligned with global trends through the growth of actualistic approaches, publication in international journals, and participation in global research networks, while still facing challenges common to many regions outside the Global North, such as uneven research coverage, limited studies in paleobotany and micropaleontology, and the need for stronger stratigraphic and geochronological integration.

CONCLUSIONS AND FUTURE PERSPECTIVES

This historical and quantitative study provides an unprecedented, data-driven panorama of the taphonomy's trajectory in Brazil. The historical and quantitative analysis of Brazilian taphonomy reveals a field that has transitioned from isolated pioneering efforts to a dynamic and expanding area of scientific inquiry. Since the late 1980s, foundational works have laid the groundwork for a steadily growing academic community. The increase in publications, the diversification of study areas, and the establishment of dedicated research groups and symposia demonstrate the institutionalization and maturation of taphonomic research in Brazil. Despite regional disparities and a modest correlation between researcher training and publication output, the field has shown resilience and adaptability.

The concentrations of research in the Southern, Southeastern, and Northeastern regions reflect Brazil's paleontological richness and research infrastructure. The predominance of English-language publications indicates strong international integration, while Portuguese-language works maintain essential local engagement. With ongoing growth in academic output and institutional initiatives, Brazilian taphonomy is well-positioned to contribute meaningfully to global paleoecological and stratigraphic discussions.

Future advances in Brazilian taphonomy will depend on strategic actions aimed at reducing current asymmetries and strengthening methodological integration. Expanding research efforts into the Central-West and Northern regions is essential to fully explore Brazil's paleontological potential and to balance the current geographic concentration of studies. The revitalization and expansion of actualistic taphonomy should be prioritized, as experimental and modern analog approaches are fundamental for refining interpretative models of fossil assemblages. In parallel, greater investment in underrepresented areas such as paleobotany and micropaleontology is necessary to broaden the taxonomic and ecological scope of Brazilian taphonomic research. Strengthening conservation paleobiology is also crucial, particularly in the context of ongoing biodiversity loss and climate change, where the fossil record can provide valuable long-term perspectives. Finally, the systematic integration of robust stratigraphic and geochronological frameworks, coupled with continued international collaboration and interdisciplinary training, will be key to consolidating Brazilian taphonomy as a globally competitive and scientifically impactful field.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article.

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AUTHOR CONTRIBUTIONS

Hermínio Ismael de Araújo-Júnior: writing – original draft, editing, visualization, investigation, formal analysis, resources.

Lais Alves-Silva: writing – review, investigation, conceptualization. Ronaldo Araujo Leoni: editing, visualization, investigation, formal analysis.

All authors gave final approval for publication and agreed to be held accountable for the work performed therein.

DECLARATION OF AI USE

We have not used AI-assisted technologies to create, review, or any part of this article.

ETHICS

This work did not require ethical approval, collecting licenses, or previous authorizations.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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