Performance of complementary therapies in controlling inflammatory signs, symptoms, and complications after lower third molar extraction: A bibliometric analysis of the top 100 most cited articles

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ABSTRACT

Objective: To conduct a bibliometric analysis of the 100 most cited articles on the use of complementary therapies for controlling inflammatory signs, symptoms, and complications after lower third molar extraction. **Methods:** An electronic search was performed on the Web of Science Core Collection database. A graphical bibliometric network was created in Power BI software (Microsoft, Redmond, Washington, USA). Spearman's correlation test was used to assess the correlation among the number of citations, journal impact factor, and the year of publication. **Results:** The selected articles received 4,199 citations, covering the years 1983 to 2023. Most publications occurred in 2016. Article citations averaged 41.99. The most frequent Keywords Plus terms, considering more than five occurrences, were “removal,” “pain,” “surgery,” and “trismus.” The main keywords defined by the authors, considering more than five occurrences, were "pain," "swelling," and "trismus." The Asian and European continents presented the highest number of publications and citations. Randomized clinical trial was the most prevalent study type. Regarding authors’ affiliations, the University of Turin stood out in the number of publications. **Conclusions:** The article with the highest number of citations was published in Serbia. Turkey and Italy accounted for the highest number of publications and citation density. Although most included studies were randomized clinical trials, improving comparison and decision-making requires methodological standardization.

Keywords: Pain, Swelling, Trismus, Postoperative period, Oral surgery procedures, Wound healing

Introduction

Lower third molar extraction may be associated with inflammatory signs, symptoms, and postoperative complications, such as pain, edema, difficulty opening the mouth, alveolar osteitis, and infection[1]. These events may significantly compromise patient comfort and the quality of life in the days following surgery[2]. Postoperative consequences may concern factors such as the surgeon's experience, surgical time, the positioning of said dental elements in the mandible, and the degree of individual inflammatory response[3]. Traditionally, managing these variables involves medications, which, although effective, may present undesirable side effects and contraindications in some cases[4].

Developing complementary strategies to optimize tissue repair, aiming to restore tissue physiology and minimize postoperative consequences, is a constant challenge in contemporary dentistry[5]. Several therapies are employed for this purpose, each with its own advantages and limitations, including low-intensity laser therapy[6], cryotherapy[7], hyaluronic acid gel[8], acupuncture[9], photobiomodulation[10], ozone therapy[11], compression dressings[12], herbal medicines[13], and the administration of blood products[14].

The scientific literature presents promising results regarding the efficacy of these therapies, although controversies exist regarding the standardization of protocols, methodological quality of studies, and reproducibility of results[15,16]. Using these practices requires a critical and evidence-based overview to ensure a safe and effective incorporation into clinical practice[5].

Thus, the bibliometric analysis provides a robust method for verifying research niches[17]. By mapping citation trends, highlighting influential studies, and identifying collaboration networks, bibliometric approaches offer considerable insights into the evolution and impact of scientific research[18,19]. To date, no bibliometric study with this theme has been performed. Thus, the present study aims to conduct a bibliometric analysis of the 100 most cited articles on the use of complementary therapies for controlling inflammatory signs, symptoms, and complications after lower third molar extraction, providing comprehensive and current knowledge about possible research lines.

Materials and Methods

Sources of Information and Search Strategy

This review was reported in accordance with the Guidelines for Reporting Bibliometric Reviews of Biomedical Literature[17]. An electronic search was performed on April 30, 2025, on the Web of Science Core Collection (WoS-CC) database. The Medical Subject Headings (MeSH), Embase Subject Headings (Emtree), and Health Science Descriptors (DeCS) platforms provided the search descriptors. The Boolean operators “AND” and “OR” combined the keywords, respecting the database’s syntax rules (Table 1).

Table 1 – Database **s**earch strategy.

Database	**Search Strategy (March 2025)**
	Primary Database
Web of Science http://apps.webofknowledge.com/	**#1** “Lower Third Molar” OR “Wisdom Teeth” OR “Wisdom Tooth” OR “Third Molar” OR "Mandibular Third Molar"
	#2 “Pain” OR “Swelling” OR “Trismus” OR “Alveolitis” OR “Alveolar Osteitis” OR “Dry Socket” OR “Socket” OR “Fibrinolytic Alveolitis” OR “Infection” OR “Cellulitis” OR “Abscess” OR “Recovery” OR “Healing” OR “Wound” OR “Outcomes” OR “Efficacy” OR “Morbidities” OR “Comparison” OR "Complications" OR "Edema" OR "Mouth Opening”
	#3 “PRF” OR “CGF” OR “PRP” OR “Platelet Rich Fibrin” OR “Platelet-Rich Fibrin” OR “IPRF” OR “Leukocyte and Platelet Rich Fibrin” OR “Concentrated Growth Factor” OR “Platelet-Rich Plasma” OR “Platelet Rich” OR “Platelet-Rich” OR “Hyaluronic Acid” OR “Cryotherapy” OR “Cold Therapy” Or “Phytotherapy” OR “Laser Therapy” OR “Low-Level Light Therapy” OR “Drain” OR “Brief Hypnotic Induction” OR “Green Tea” OR “Propolis” OR "Suture Techniques" OR “Piezosurgery” OR "Acupuncture" OR "Herbal Medicine" OR "Curcumin" OR "Bromelain" OR “Arnica" OR "Photobiomodulation" OR "LLLT" OR "PBM" OR "Autologous Conditioned Plasma" OR "A-PRF" OR “T-PRF" OR “Cryotherapy" OR "Ozone” OR “Therapy” OR "Ozonated Water” OR “Minimal" or "Transcutaneous Electrical Nerve Stimulation” OR “TENS" OR “Ultrasound" OR "Kinesio Taping” OR “PRGF" OR "Plasma Rich in Growth Factors” OR "Collagen Membrane” OR "Collagen Resorbable Membrane” OR “Chitosan" OR "Pulsed Electromagnetic Field” OR "Probiotic"
	#1 AND #2 AND #3

Eligibility Criteria

The study included the 100 most cited articles that investigated the performance of complementary therapies in controlling inflammatory signs, symptoms, and complications after lower third molar extraction. There was no restriction on the year or language of publication.

Selection Process

Two independent researchers (VLA and DCF) assessed title and abstract readings, as well as full texts when necessary. A third investigator (LRP) was consulted in cases of discrepancies.

Data Extraction from the Selected Studies

The following data were extracted from each included article: the year of publication, the number of citations, position in the list of citations, citation density, the number of general citations, title, authors, institution, country, journal, impact factor (IF) according to the Journal Citation Reports (Clarivate Analytics), keywords, study design, open access policies, and other topics of interest. Study designs were categorized into systematic reviews, systematic reviews with meta-analyses, umbrella reviews, narrative reviews, literature reviews, clinical practice guidelines, prospective articles, clinical trials, observational studies (cohort, cross-sectional, and case-control), and *in vitro*/animal studies. The collected data from countries and institutions were based on information from the corresponding authors. International collaboration considered the institution of origin of each author and co-author. Two evaluators (VLA and DCF) analyzed the data independently to minimize error. The topic of interest evaluated in this bibliometric analysis was the performance of complementary therapies in controlling inflammatory signs, symptoms, and complications after lower third molar extraction.

Data Analysis

A graphical bibliometric network was created in Power BI software (Microsoft, Redmond, Washington, USA). The data related to connections between authorship and keywords were clustered. Terms associated with clusters and larger fonts had higher occurrences, while terms associated with clusters or smaller fonts had lower occurrences. Connection lines were drawn between clusters to indicate relationships.

Spearman's correlation test was used to assess the correlation among the number of citations, journal impact factor, and the year of publication. Spearman's correlation coefficient (rho) may be weak (rho >0.30), moderate (rho >0.50), high (rho >0.70), or very high (rho >0.9). All analyses were performed in R software (version 4.5 for Windows) at a 5% significance level.

Results

The search strategy in the WoS-CC database yielded 888 studies, which were classified by the number of citations. After screening, the 100 most cited articles were selected[20-119]. Kaziro (1984) authored the first article to analyze the performance of complementary therapies in controlling inflammatory signs, symptoms, and complications after lower third molar extraction[20]. It was published in the British Journal of Oral and Maxillofacial Surgery and received 54 citations. The most recent article, Elayah et al. (2023), was published in Frontiers in Endocrinology and received 21 citations[21]. A very weak positive correlation was found between journal impact factor and the number of citations (rho = 0.249, p = 0.01).

The selected articles received 4,199 citations, covering the years 1983 to 2023. The highest number of publications occurred in 2016 (n = 12), as shown in Figure 1, which also presents citation trends. There was a moderate negative correlation between the year of publication and the number of citations (rho = -0.597, p <0.001). Article citations ranged from 10 to 125, with an average of 41.99 citations per article. The most cited article, a randomized clinical trial published in the International Journal of Oral and Maxillofacial Surgery in 2007 by Markovic and Todorovic, had 125 citations[22]. The most frequent Keywords Plus terms, considering more than five occurrences, automatically generated by WoS-CC were "removal" (1,698 citations), "pain" (1,256 citations), "surgery" (1,079 citations), and "trismus" (1,006 citations), as seen in Figure 2. The main keywords defined by the authors, considering more than five occurrences, were "pain" (1,400 citations), "swelling" (900 citations), and "trismus" (800 citations), as shown in Figure 3.

Regarding geographical distribution, Asia had the highest number of publications and citations (50% of articles, 1,929 citations), followed by Europe (33 articles, 1,518 citations), Latin America (9 articles, 370 publications), Africa (6 articles, 275 publications), and Anglo-Saxon America (2 articles, 107 citations). Turkey stood out with 22% of publications and 857 citations. Italy (13%, 718 citations), India (11%, 448 citations), Brazil (9%, 370 citations), Iran (9%, 316 citations), Spain (6%, 226 citations), and Nigeria (5%, 212 citations) individually exceeded 200 citations, as seen in Figure 4. Figure 5 illustrates the international collaboration network of countries. Among the 100 most cited articles, only nine countries collaborated, with Italy having the highest number of international collaborations and consequently more citations (6 articles, 237 citations).

The randomized clinical trial was the most prevalent study type (87% of selected articles) and obtained the highest number of citations (3,548 citations), followed by quasi-randomized clinical trials (11% of articles, 571 citations). Only one article was identified for case-control (48 citations) and observational (32 citations) study designs, as shown in Figure 6.

Among the 100 most cited articles, only two were published by a single author[20,23]. The radar plot (Figure 7) shows the authors with two or more occurrences and 80 or more citations: Aras MH and Gungormus M (129 citations), Mozzati M (126 citations), Uyanik LO (124 citations), and Ezirganli S (116 citations).

Regarding authors' affiliations, the Aster plot in Figure 8 shows the five main institutions, considering only those with two or more occurrences and 80 or more citations. The University of Turin stood out with four articles and 211 citations, followed by Bezmialem Vakif University (3 articles, 152 citations), Federal University of Pernambuco (2 articles, 143 citations), Inonu University (4 articles, 130 citations), and Istanbul University (3 articles, 130 citations).

Discussion

Developing complementary therapies for controlling inflammatory signs, symptoms, and complications after lower third molar extraction is a trend in contemporary dentistry[5]. This bibliometric analysis is the first study to analyze the top 100 most cited articles on this topic.

In this study, the article that received the most citations was by Markovic and Todorovic (2007)[22], with 125 citations, while the study by Momeni et al. (2022)[119] received only 10 citations. Factors such as methodological quality, journal impact factor, and collaboration research network may influence citation metrics (Tahamtan et al., 2016)[120]. However, the article that received the fewest citations (Momeni et al., 2022)[119] was published in BMS Oral Health, whose impact factor is 3.1, which is higher than the impact factor of the study with the most citations (Markovi and Todorovic, 2007)[22] published in the International Journal of Oral and Maxillofacial Surgery. This difference may be linked to factors that influence citation metrics, such as the novelty of the researched theme and the time of article publication[121]. It is worth noting that Spearman's test presented a very weak positive correlation between journal impact factor and the number of citations (rho = 0.249, p = 0.01).

Randomized clinical trial (RCT) was the most frequent study type, representing 87% of the selected articles. This study design randomly selects patients to receive the intervention or control, ensuring the balance of potential known and unknown confounding factors at the time of randomization[122]. Moreover, the RCT may provide strong evidence for research evaluating the effectiveness of a clinical intervention, aiding evidence-based decision-making[123]. However, although most selected studies were RCTs, the comparison of interventions presents methodological flaws, as some studies lack sample calculation, parallel and split-mouth designs, and heterogeneous positioning of third molars in the mandible. These points are outside the protocol suggested by the Consolidated Standards of Reporting Trials (CONSORT) and may influence the interpretation, inference of results, and decision-making (Butcher et al., 2022)[124].

Asia and Europe contributed the highest number of articles among the 100 most cited on complementary therapies for controlling inflammatory signs, symptoms, and complications after lower third molar extraction. This data contrasts with Huang et al. (2025)[125], whose bibliometric analysis showed that Brazil contributed the highest number of articles among the top 100 most cited, including research on pain control and drug use after lower third molar extraction. This difference may be attributed to the larger number of therapies analyzed and the broader scope of research lines and groups included in this study. Although Brazil does not rank in a prominent position regarding the number of scientific publications among the top 100 most cited articles in this study, the Federal University of Pernambuco contributed two articles and 143 citations among the five most cited higher education institutions. The four

other most cited institutions are in Asia and Europe, corroborating the continents that contributed the most published articles on this subject.

Turkey and India are among the countries with the most scientific contributions in the top 100 most cited articles, and they stand out in the research on complementary therapies after lower third molar extraction, mainly addressing the application of laser therapy and blood concentrates. These countries have consolidated their presence in the global scientific research landscape through significant advances in production and infrastructure. India, which became the third country to publish the most scientific articles in 2022, with approximately 177,291 articles, registered a 19% growth compared to the previous year[126]. Turkey has significantly expanded its presence in international scientific research, reflected by several bibliometric indicators. From April 1, 2024, to March 31, 2025, the country ranked 34th in the global ranking of scientific production by the Nature Index, and 4th in the Western Asia region, with emphasis on physical, health, biological, land, and environmental sciences[127].

Keywords are critical for the effectiveness of a literature search strategy, as they condense longer sentences or phrases and expand the ability to track articles[128]. In the present study, the main keywords defined by the authors were “pain,” “swelling,” and “trismus.” Notably, these terms correspond to the most frequent inflammatory signs and symptoms after lower third molar extraction, which justifies the emphasis of such terms as the main keywords referring to the top 100 most cited articles. Although pain, edema, and difficulty opening the mouth are common after this surgical procedure, the intensity of these inflammatory signs and symptoms might be strongly related to the degree of surgical difficulty, individual tissue repair response, and the surgeon’s experience[99,129].

Although it is relevant as an analysis method for mapping existing research and providing knowledge of the geographic distribution and influence of each continent regarding their scientific contribution, this bibliometric analysis has some limitations. Robust studies on the subject exist, but they may not have been included due to the recent date of publication, which consequently yields few citations. The WoS-CC database is among the most reliable and widely used citation databases for bibliometric studies[130]. However, as it was the only database used, other robust studies with a high number of citations may not have been retrieved. Thus, future studies should include more databases, such as Scopus.

Conclusion

This bibliometric analysis identified the 100 most cited articles on the performance of complementary therapies in controlling inflammatory signs, symptoms, and complications after lower third molar extraction. The article with the highest number of citations was published in Serbia. The Asian and European continents presented the highest number of studies, with Turkey and Italy accounting for the most publications and density of citations.

Although most included studies were randomized clinical trials, improving comparison and clinical evidence-based decision-making requires methodological standardization.

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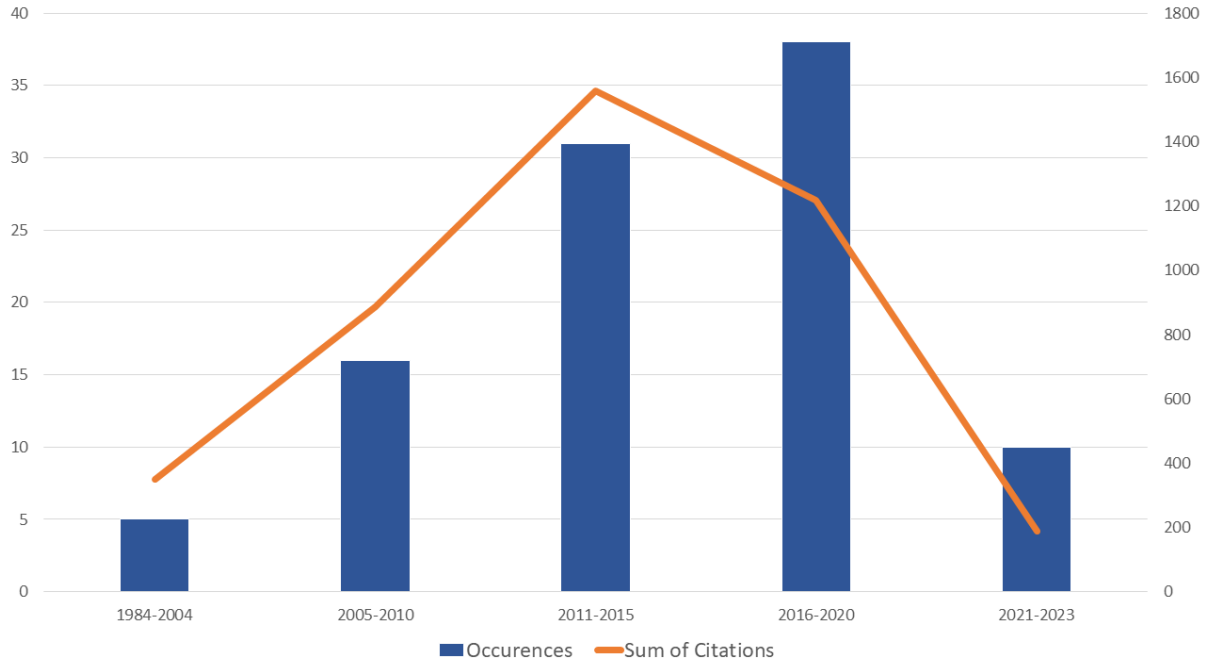


Figure 1- Trend in publications and citations over time.

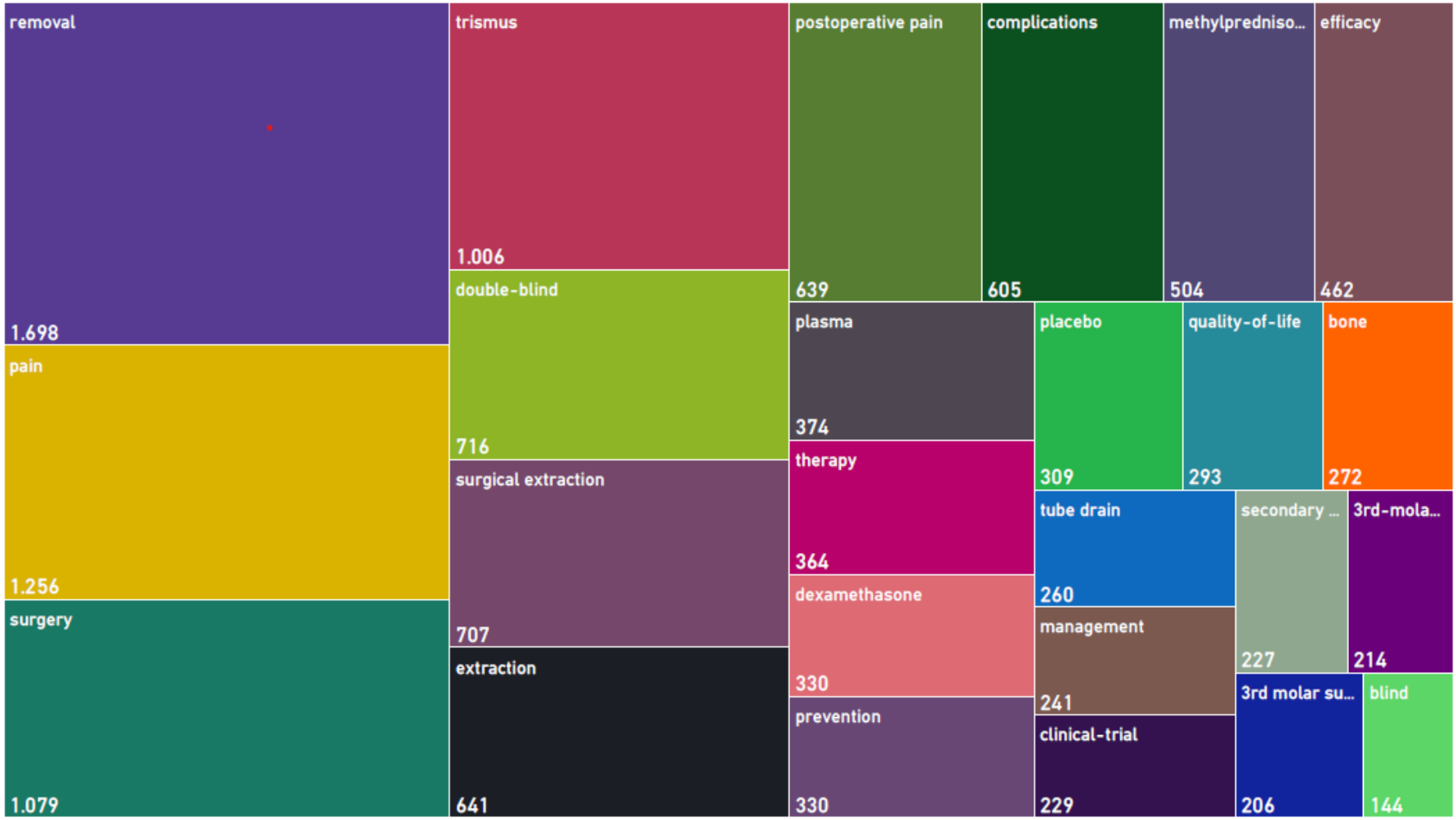


Figure 2- Tree map of Keywords Plus, which are the index terms automatically generated from the titles of cited articles in the WoS-CC database. Larger boxes indicate a higher sum of citations.

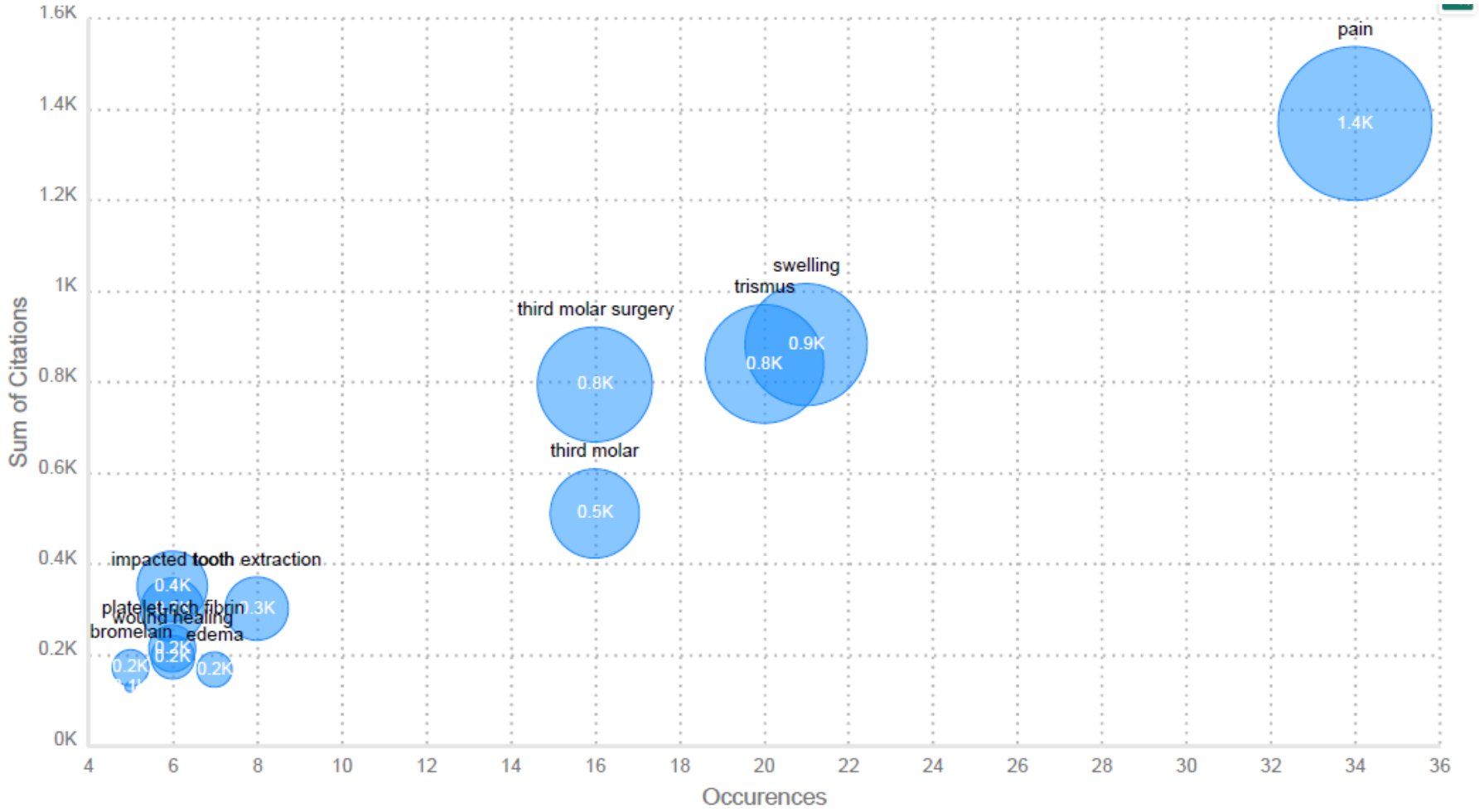
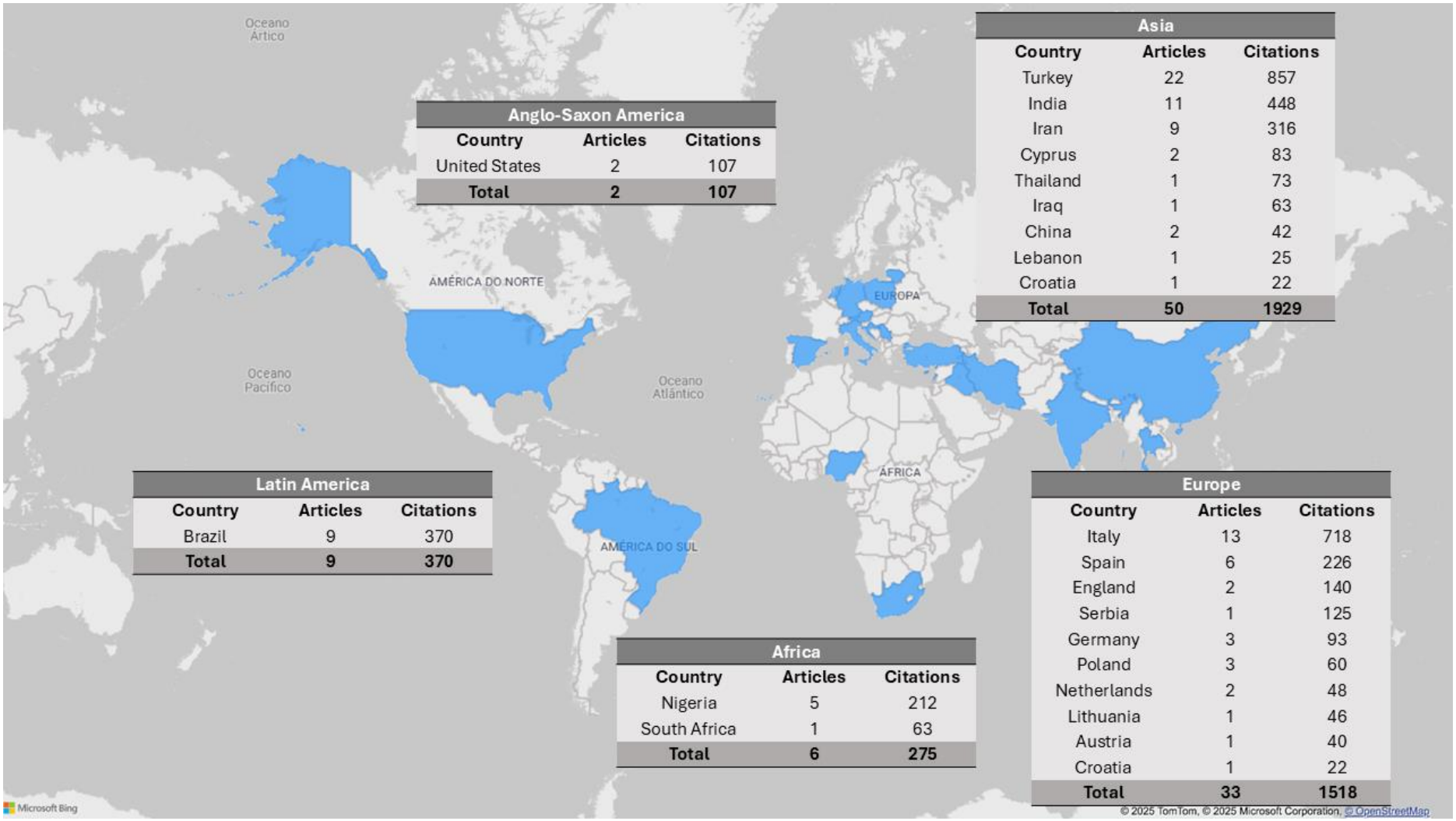


Figure 3- Keywords defined by the authors, considering more than five occurrences. A filter was applied to display only keywords whith more than 5 occurences.



Anglo-Saxon America

Country	Articles	Citations
United States	2	107
Total	**2**	**107**

Asia

Country	Articles	Citations
Turkey	22	857
India	11	448
Iran	9	316
Cyprus	2	83
Thailand	1	73
Iraq	1	63
China	2	42
Lebanon	1	25
Croatia	1	22
Total	**50**	**1929**

Latin America

Country	Articles	Citations
Brazil	9	370
Total	**9**	**370**

Europe

Country	Articles	Citations
Italy	13	718
Spain	6	226
England	2	140
Serbia	1	125
Germany	3	93
Poland	3	60
Netherlands	2	48
Lithuania	1	46
Austria	1	40
Croatia	1	22
Total	**33**	**1518**

Africa

Country	Articles	Citations
Nigeria	5	212
South Africa	1	63
Total	**6**	**275**

Figure 4- Distribution of publications and citations of the 100 most-cited articles across continents, based on corresponding authors.

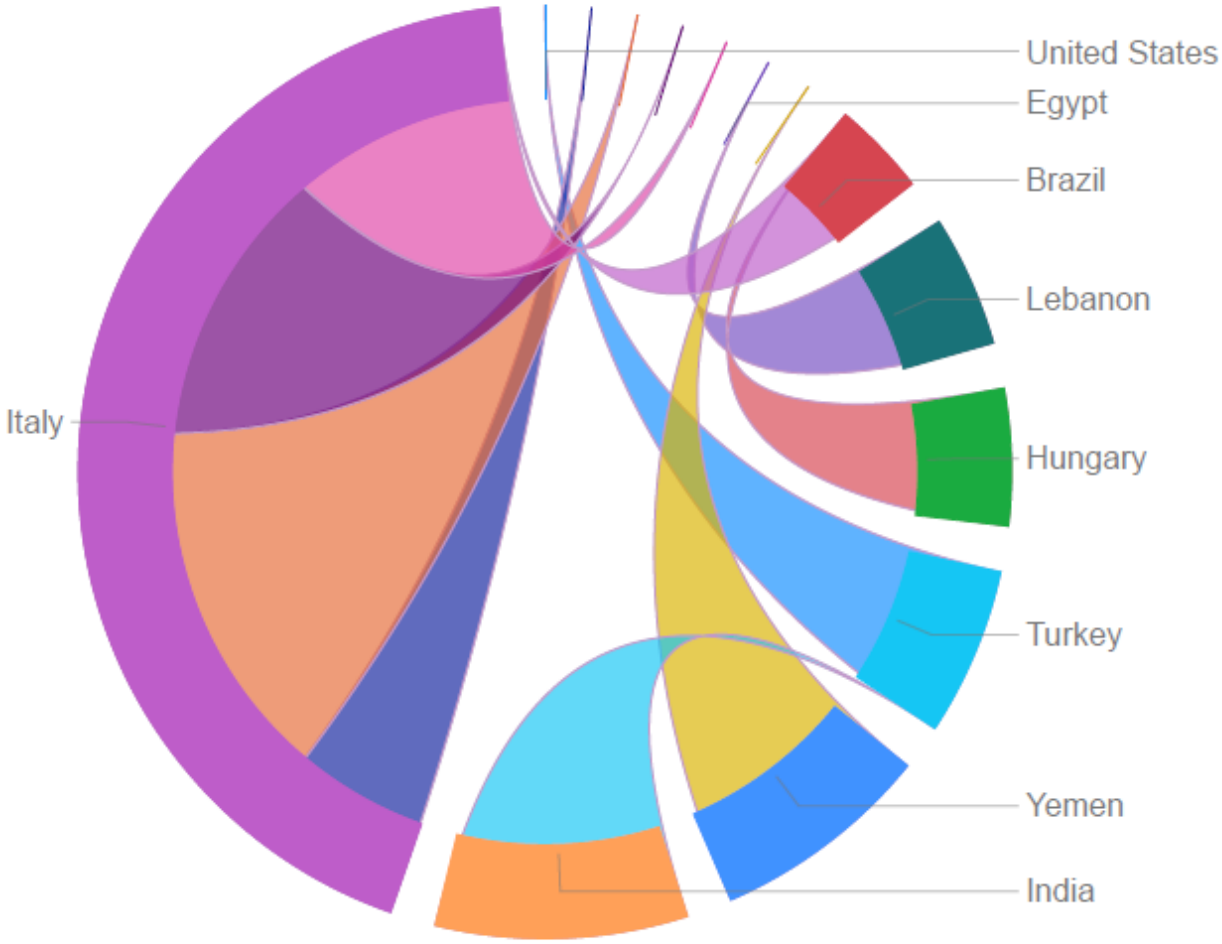


Figure 5- International collaborations are visualized through a chord diagram, reflecting affiliations of all contributing authors. The colors of the chords represent the destination of each collaboration.

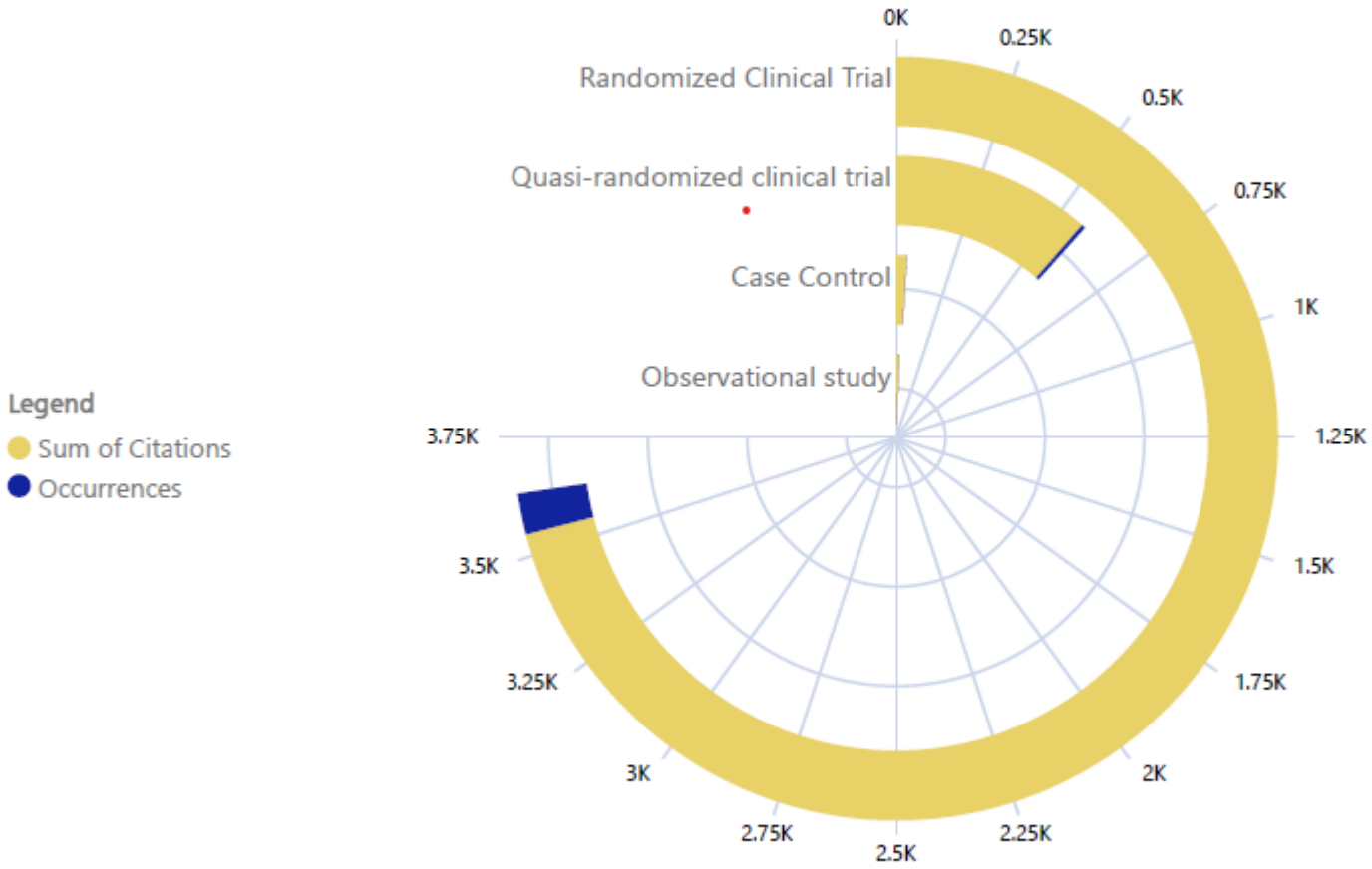


Figure 6- Prevalence of articles and citations across various study designs within the top100 studies.

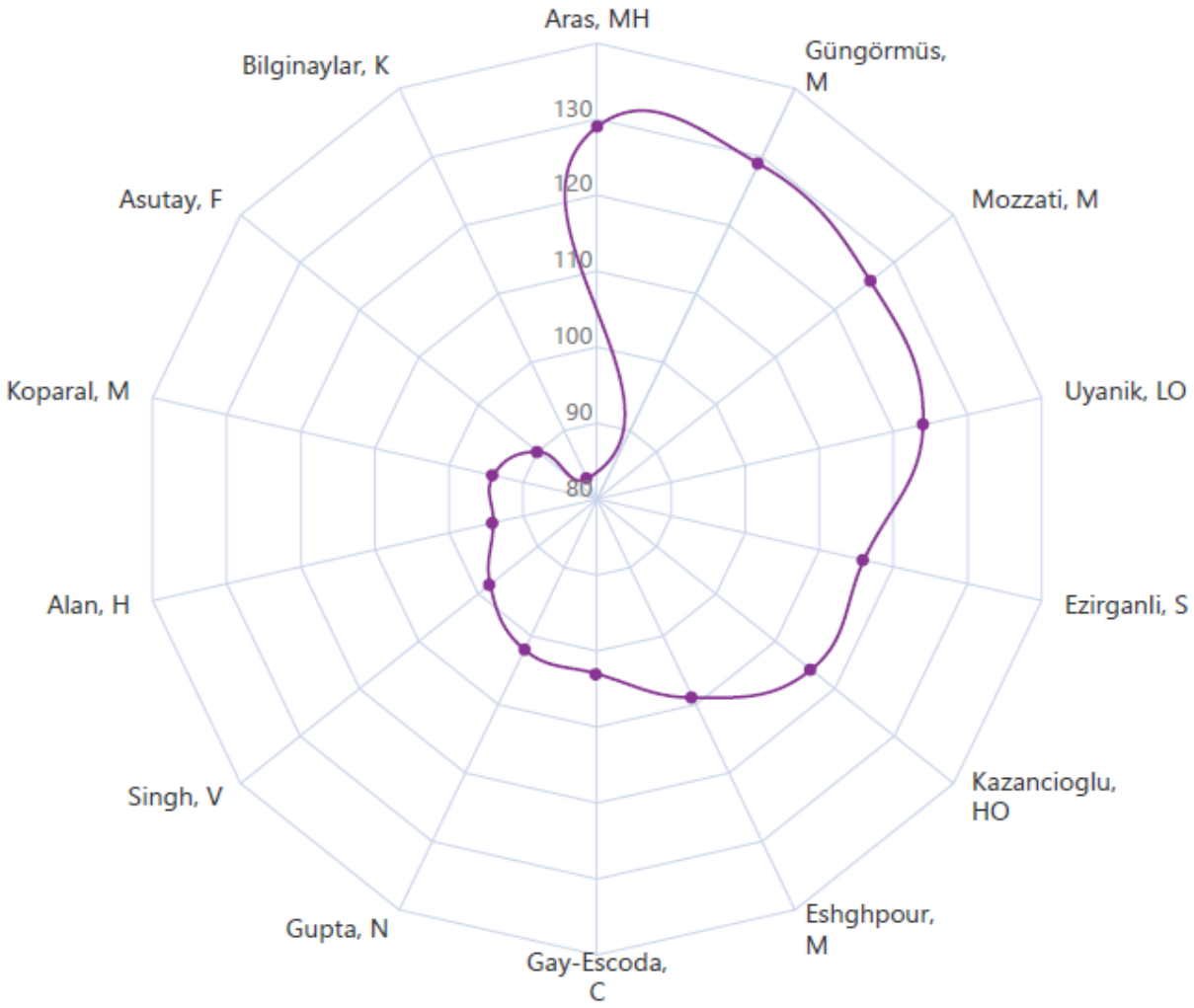


Figure 7- Radar chart showing authors with two or more occurrences and 80 or more occurrences.

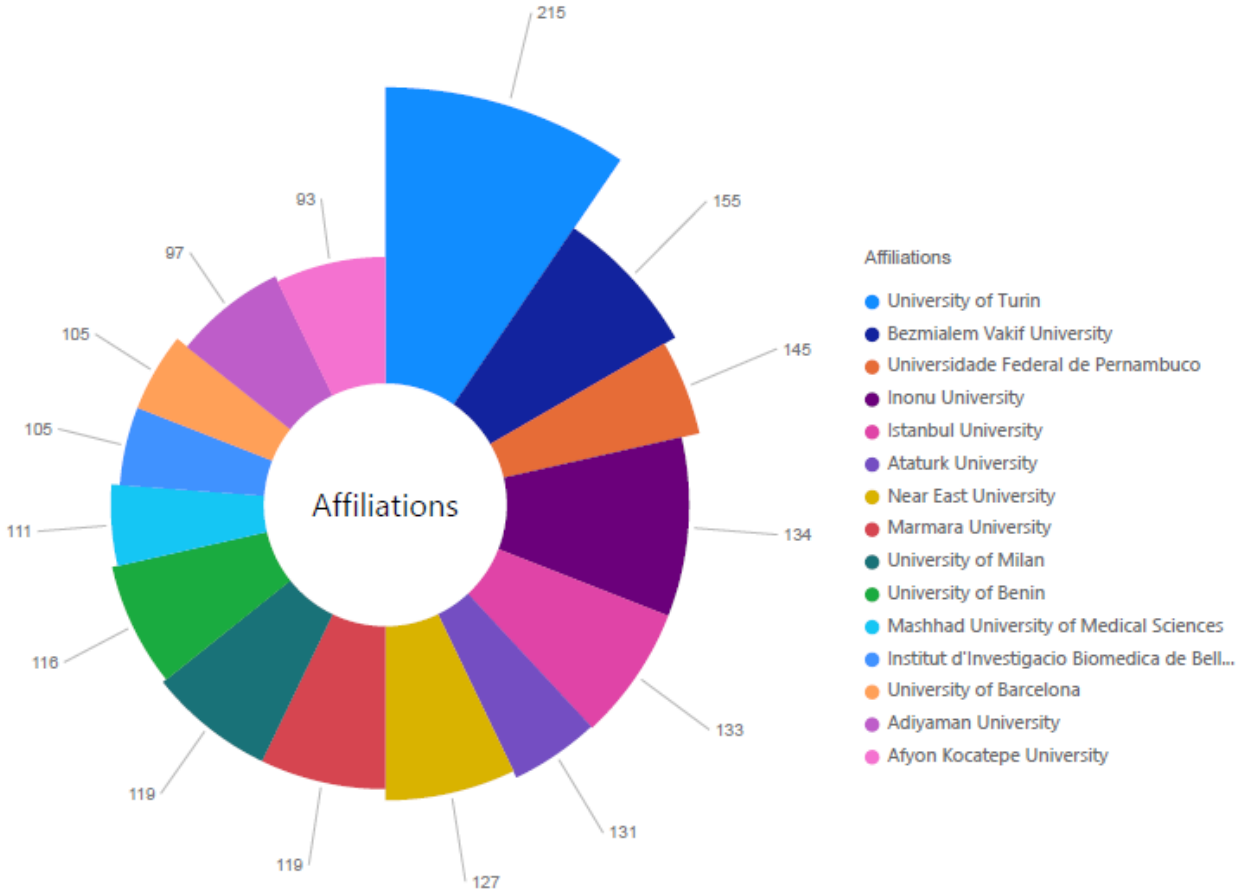


Figure 8- Aster diagram demonstrating author affiliations, considering those with two or more occurrences and 80 or more citations

Authors' Contribution Statement

Vinícius Lima de Almeida: Conception and design, data analysis and interpretation, manuscript drafting, final approval.

Danilo Cassiano Ferraz: Conception and design, data analysis and interpretation, manuscript drafting, final approval.

Giovanna Miranda Cabral: Data analysis and interpretation, manuscript drafting.

Arthur Henrique Gobbi: Data analysis and interpretation, manuscript drafting.

Walbert Andrade Vieira: Data analysis and interpretation, manuscript drafting, final approval.

Lívia Bonjardim Lima: Data analysis and interpretation, manuscript drafting.

Rafael Rodrigues Lima: Data analysis and interpretation, manuscript drafting.

Sigmar de Mello Rode: Data analysis and interpretation, manuscript drafting.

Luiz Renato Paranhos: Manuscript drafting (review), final approval.

Conflict of interest

The authors declare that they have no conflict of interest.

Research Data Availability Statement

The entire data set supporting the results of this study was published in the article itself.

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