



Bibliometric Review of Anatomical Terminology

Ahmad Fasichul Iman^{1*}, Yunia Hastami², Selfi Handayani², Siti Munawaroh², Nanang Wiyono²

¹Department of Anatomy, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia; ²Department of Anatomy and Embryology, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia

Abstract

Edited by: Slavica Hristomanova-Mitkovska

Citation: Iman AF, Hastami Y, Handayani S, Munawaroh S, Wiyono N. Bibliometric Review of Anatomical Terminology.

Open Access Maced J Med Sci. 2023 Jan 06; 11(A):236-242.
https://doi.org/10.3889/oamjms.2023.11259

Keywords: Terminologia anatomica; Anatomy; Bibliometry

***Correspondence:** Ahmad Fasichul Iman, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia.
E-mail: zicoiman20@student.uns.ac.id

Received: 26-Nov-2022

Revised: 30-Nov-2022

Accepted: 26-Dec-2022

Copyright: © 2023 Ahmad Fasichul Iman, Yunia Hastami, Selfi Handayani, Siti Munawaroh, Nanang Wiyono

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Open Access: This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

BACKGROUND: Anatomy is an important part of medicine. Anatomical terminology also become the basis for studying anatomy in particular and medicine in general. The need for standardization becomes something important in ensuring effective communication.

AIM: This study aims to conduct a bibliometric analysis of publications related to anatomical terminology to understand its development.

METHODS: This study uses bibliometric method. The data used in this study were obtained from the Scopus database with publication related to anatomical terminology. The data obtained was then processed using VOSviewer software to create a bibliometric map for later analysis.

RESULTS: There were 1821 publications published from 1914 to 2021 related to anatomical terminology. There was an increase in publications from year to year with the highest number of publications in 2020 with 101 publications. Based on the bibliometric map, the keywords "anatomical terminology" and "latin anatomical terms" were the most widely published in recent years.

CONCLUSION: This study shows that anatomical terminology is still being developed to ensure more effective communication between professionals.

Introduction

Anatomy is the earliest branch of medicine taught to all students in all fields of medicine. This relates to the role of anatomy as the core of medicine studies and considered to be a part that must be mastered by professionals. Changes that then occurs in the human body caused by a pathological process can be easily identified when normal structures is comprehended. Anatomy forms the basis for examination, formulation of a diagnosis, and presentation of findings to patients and health professionals. Anatomy also forms the base for performing invasive, emergency, and other procedures [1].

A comprehensive understanding of anatomy provides a solid foundation to start learning medicine. Nevertheless, the importance of studying anatomy in the medical curriculum has recently become a topic of contention among medical professional [2]. According to Moxham, learning hours, teaching staff, and time allocated on dissection in certain topics of anatomy have decreased over the past decades. Anatomy has become something only to be passed and not an important learning process that must be mastered [3]. Nevertheless, the process of analysis, revision, and then development of anatomy continues. As all medical

professionals agree, a good understanding of anatomy is related to the clinical competence of professionals [4].

Throughout history, anatomy has been the initial bridge in studying medicine. Likewise, anatomical terminology acts as a bridge to understand anatomy specifically and medicine in general [5]. Anatomical terminology has become the basis of medical languages used all over the world. The anatomical terminology has developed in the past 2500 years and comes from the scientific language commonly used ancient Greek and Latin civilization [6]. Anatomy itself means "cut" in ancient Greek, the parts that were cut were then given an appropriate name. The terminology used today is the result of the development of the names given at the beginning of its discovery and the colloquial language used by clinical practitioners at that time. The language that was previously only used in everyday conversation between clinicians was then used as a means to write findings, share knowledge among professionals, and teaching methods for students in the medical field. The development of medical science makes anatomical terminology then develops to be more plentiful and complete [7].

Terminology that is precise, clear, comprehensive, and accepted by all medical professional in the world is important. It can prevent confusion, misinterpretation, and errors in communication between

professionals. As the oldest part of medicine, anatomy and its terminology form the basis of various other branches of science such as biology, midwifery, and nursery. Although some clinicians do not pay attention to the use of correct and precise terminology, the use of incorrect terminology can lead to miscommunication of information that can end up fatal. So that the need for precise, clear, and accepted terminology by all circles is something that cannot be debated. An international agreement for grammatical and anatomical terminology was then formed. *Terminologia Anatomica*, published in 1998, later became a means to standardize anatomical terminology [8].

The International Federation of Anatomical Associations (IFAA) has been the organization that compile and publishes official anatomical terminology in 1998. Federative International Program on Anatomical Terminology (FIPAT) is part of IFAA which specifically ensures democratic input of terminology from all members. Since its establishment, FIPAT formerly known as Federative Committee on Anatomical Terminology (FCAT) only published one version of *Terminologia Anatomica* in 1998. The draft for *Terminologia Anatomica 2* as a revision of the first version, which was published more than 20 years ago, has been publicly available and published in 2019 [9]. In *Terminologia Anatomica*, there are two official versions of anatomical terminology, namely, in Latin and English. Some medical professionals in the world, in clinical practices, use English as a substitute for Latin, this then causes some confusion, because based on *Terminologia Anatomica*, anatomical terminology in English still has some incorrect words, inaccuracy, or errors [10].

As an important part of anatomy, anatomical terminology continues to receive attention from the international medical community. *Terminologia Anatomica* which is considered to be in need of renewal and the new update of it, which still needs to be revised, has made anatomical terminology a subject of research that is growing rapidly. Anatomical terminology that is clearer, more precise, and can be used by medical professional internationally is very important to ensure that there are no errors in scientific or clinical activities. The publication of a new version of anatomical terminology indicates that there are continuing changes in the terminology we use. Some of these changes occurred because of the need to rearrange, too simple or complicated, the discovery of parts that previously did not have names or named incorrectly. In general, there is a trend toward more precise and appropriate terminology for the benefit of health sciences [11].

Bibliometry is a research approach used to measure and analyze the impact of scientific work on a particular research [12]. Bibliometry is a meta-science study that makes science its object of study. Bibliometrics uses three elements of scientific activity as a basis: input, output, and influence of a publication. These three elements can then be mapped and used to

expand knowledge in a particular research area. This study clarifies the interrelationships between authors, publications, institutions, and other characteristics of a particular field [13]. The popularity of bibliometric studies is on the rise. The advancement, availability, and accessibility of bibliometric software such as VOS viewer, the cross-disciplinary characteristics of bibliometric methodologies, their usefulness for processing scientific data on a large scale, and high research impact have been directly linked to the popularity of bibliometric studies [14].

Despite the increasing popularity of bibliometric studies, based on analysis of bibliometric scientific publications in the field of anatomy, are still very few [15]. Further bibliometric research that specifically examines publications related to anatomical terminology is, to date, not available. Thus, to find out the extent of the development and trend of publications related to anatomical terminology, further research is needed as a basis for further research and the development of medical science broadly.

Methods

This study aims to analyze the bibliographic record, research activity, and dynamics related to terminology anatomy. As such, a bibliometric review of this topic in terms of both performance analysis and science mapping is conducted in this paper.

The study was conducted in two main phases. First, a search was carried out in the Scopus database, where scopus is one of the most comprehensive peer-reviewed journal databases in the world and can provide credible scientific and academic information [16]. Second, using the data that has been extracted, VOS viewer software was used as a tool to visualize and structure a bibliometric maps and information. Third, we analyze the data that has been processed as a bibliometric analysis (Figure 1).

Data collection

To gather the literature data, a search strategy was used on the Scopus database. Utilized the search category of "Article title, Abstract, and Keywords" we used the keyword "Anatomy OR Anatomica OR Anatomical OR Anatomically and Terminology OR Terminologia." The search was conducted on September 14, 2022. The data sample then downloaded in *.csv format.

Data processing and analyzing

The extracted data then used in VOS viewer to visualize and analyze trends in the form of bibliometric

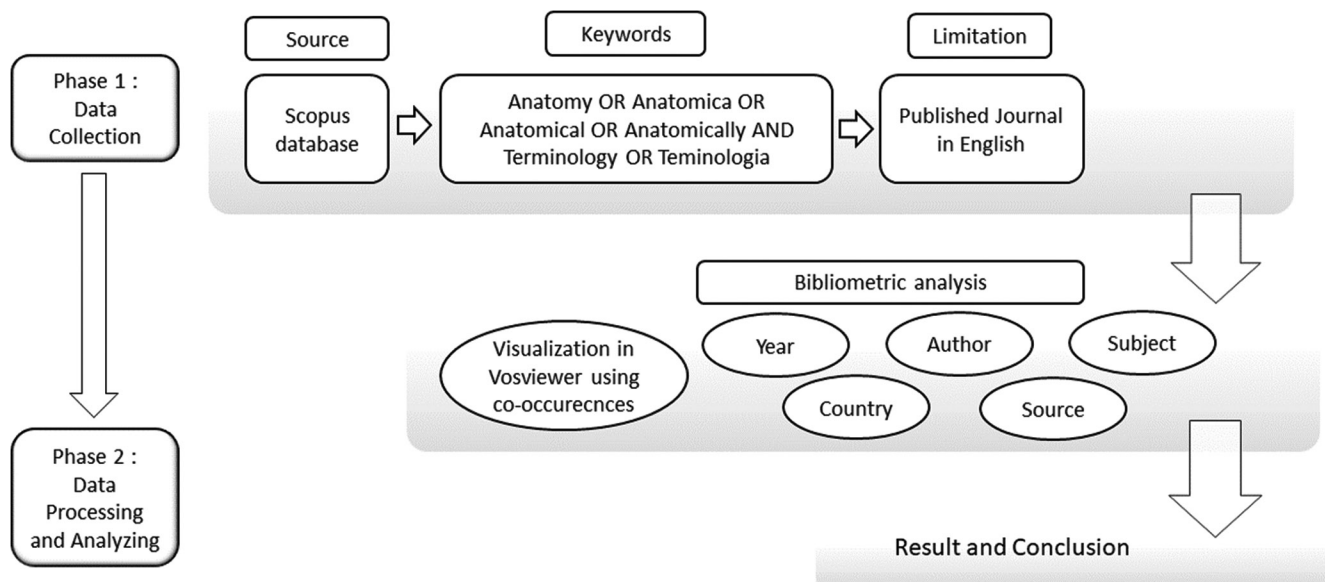


Figure 1: Research method

maps. This software VOS viewer (version 1.6.17) has widely used in making visualization of bibliometric networks. This software allows extraction of information from the data, such as authorship, time period, countries, and keywords. The result is then shown as interlocking keywords for viewing existing connections between bibliometric data.

To analyze the data, we used the manual of the software. From the map VOS viewer has presented, the distance between two or more circles indicates the strength of link between each term. Different clusters are represented by different colors. The size of the circles is in correlation with the frequency of appearance of the term.

Results

Based on the bibliometric data that was compiled and arranged in Figure 2. On the topic of Anatomical Terminology on a period as early as 1914 until 2021 a total of 1821 publication was retrieved. Those publication was published in 160 journals, written by 159 authors, and based on 89 countries Moreover, as seen in Figure 3. Those publication received a total of 70.183 citations. The analysis reveals that there was a steady growth on the number of publications related to anatomical terminology. This growth can be addressed in the needs of a standardized anatomical terminology for professionals [5]. The most productive year in terms of publication was in 2020 with 101 publications. The spike in publication is related to the publication of *Terminologia Anatomica 2*, which is a revised version of the previous *Terminologia Anatomica* that was published in 1998. The publication related to TA2 was used to popularize and criticized the revised term in

TA2 as a standardized and authoritative arrangement on anatomical terminology [10].

Table 1 shows the five publications with the highest number of citations. All publications shown in the table received more than 1000 citations and were published from 1995 to 2010. The publication with the highest number of citations is a publication titled “The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction” which was published in 1996.

Table 1: Top 5 publications based on citations

| Publication title | Writers | Citations |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------|
| The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction | Bump R.C., Mattiasson A., Bo K., Brubaker L.P., et al. | 3421 |
| Standardization of uveitis nomenclature for reporting clinical data. Results of the first international workshop | Jabs D.A., Nussenblatt R.B., Rosenbaum J.T., et al. | 2838 |
| ISB recommendation on definitions of joint coordinate systems of various joints for the reporting of human joint motion-part II: Shoulder, elbow, wrist and hand | Wu G., Van Der Helm F.C.T., Veeger H.E.J., et al. | 2418 |
| Automatic parcellation of human cortical gyri and sulci using standard anatomical nomenclature | Destrieux C., Fischl B. Dale A., Halgren E. | 1433 |
| A probabilistic atlas of the human brain: Theory and rationale for its development | Mazziotta J.C., Toga A.W., Evans A., Fox P., Lancaster J. | 1174 |

Keyword mapping was carried out to see the scope of research and the main topics of publications related to anatomical terminology. This analysis is conducted to determine the latest research trends and emerging research topics. From the keyword analysis, a total of 4421 keywords were obtained and among those keywords, 38 keywords met the cooccurrence criteria for minimum of 7 times.

The size of the label shows the number of occurrences and the number of relationships with other keywords, the larger the size of the label, the more the number of occurrences of the word, and the more relationships the word has with other keywords. The five keywords with the highest number of occurrences

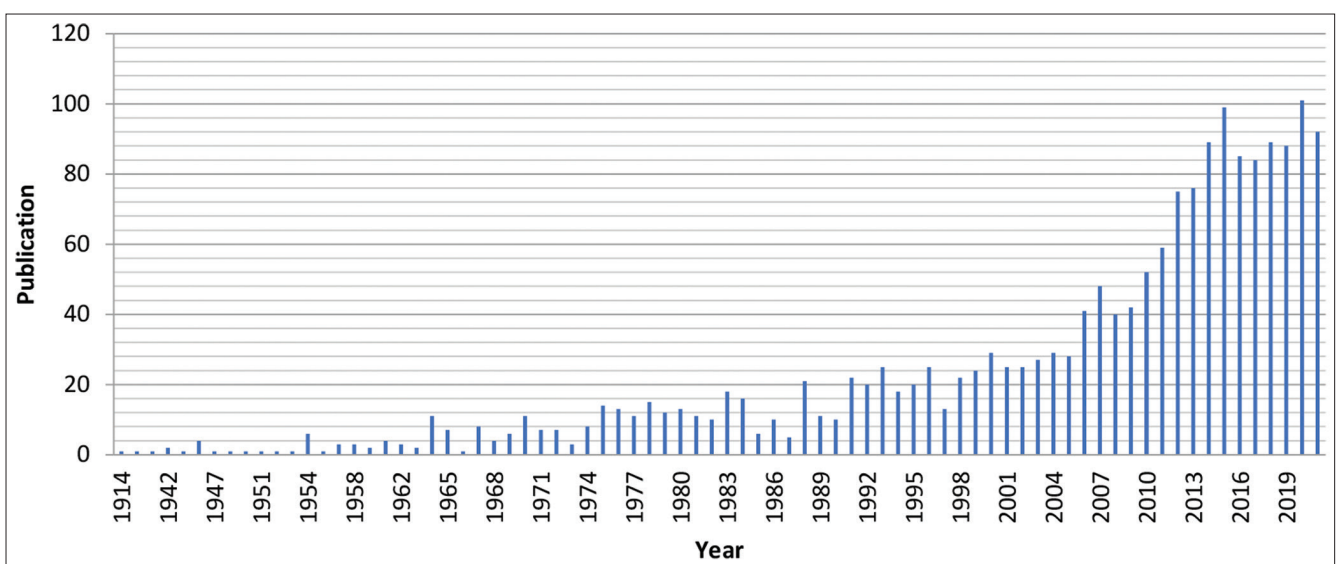


Figure 2: Distribution of publication annually

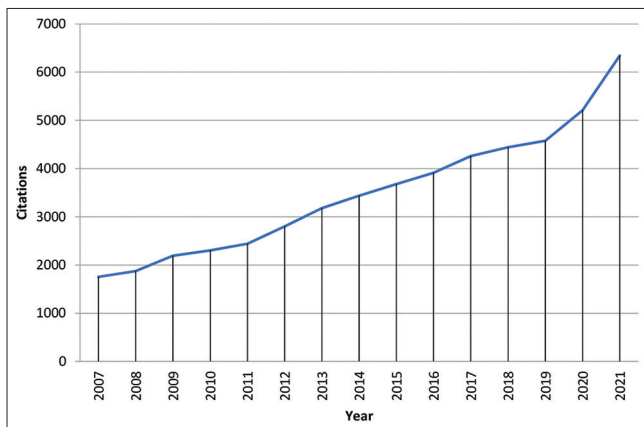


Figure 3: Citations by year

that can be observed in Figure 4 are “Anatomy,” “Terminology,” “Nomenclature,” “Morphology,” and “Anatomical nomenclature.”

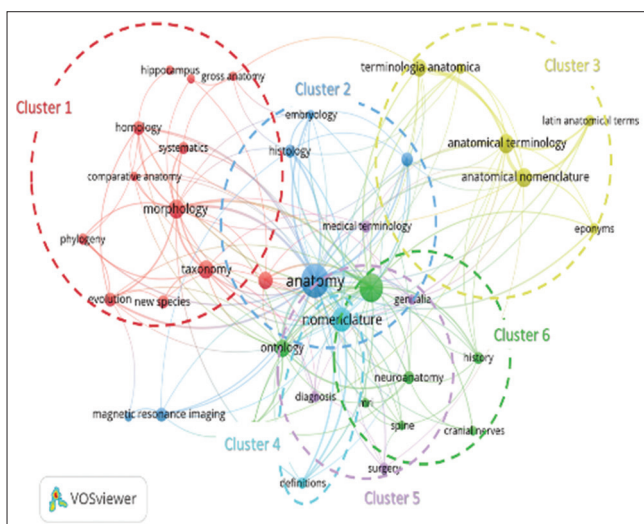


Figure 4: Visualization of bibliometric maps and keywords cluster

Figure 5 shows the development of research topics related to anatomical terminology. Keywords

such as “Anatomical Terminology,” “*Terminologia Anatomica*,” and “New Species” are shown in bright yellow, which means that research related to these keywords is relatively new.

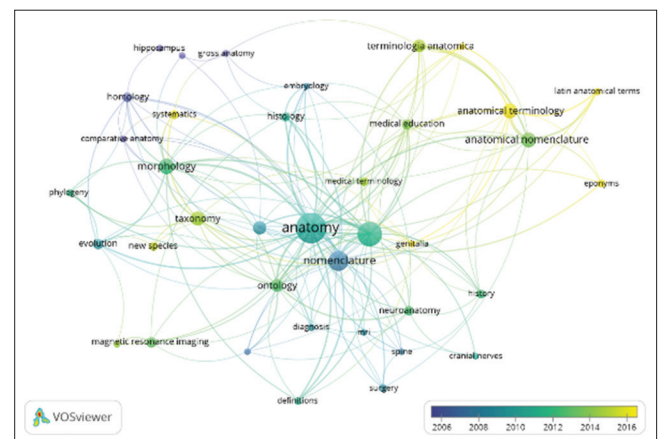


Figure 5: Visualization of bibliometric maps based on year

The research topics most related to anatomical terminology in the Scopus database are Medicine with 1252 publications (49%), followed by Agricultural and Biological Sciences with 317 publications (12.4%), biochemistry, genetics, and molecular biology with 264 publications (10.3%), followed by neuroscience with 123 publications (4.8%). Fields of research related to anatomical terminology are shown in Table 2.

Table 2: Top 5 research topic related to anatomical terminology

| Research topics | Publication |
|-----------------------------------------------|-------------|
| Medicine | 1252 |
| Agricultural and biological sciences | 317 |
| Biochemistry, genetics, and molecular biology | 264 |
| Neuroscience | 123 |
| Social sciences | 71 |

There were 160 journals that publish publications related to anatomical terminology. The five most productive journals that published article related to anatomical terminology are shown in Table 3. The journal that publishes the most publications related to

anatomical terminology is the Zootaxa Journal with 65 publications. Then followed by Clinical Anatomy with 58 publications, Journal of Comparative Neurology and Plos one was next with 32 publications.

Table 3: Top 5 journals based on publication counts

| Journal | Publications |
|----------------------------------|--------------|
| Zootaxa | 65 |
| Clinical anatomy | 58 |
| Journal of comparative neurology | 32 |
| Plos one | 32 |
| Surgical and radiologic anatomy | 29 |

Based on data, United States is the country with the greatest number of publications with 764 publications (29.1%), followed by England with 200 publications (7.62%) and Germany with 156 publications (5.94%). Based on the bibliometric map in Figure 6, regarding the relationship between countries, the United States also dominates the publication relationship related to anatomical terminology. Greece as the country of origin of anatomical terminology study, contributed 34 publications and also not in the vicinity of international collaboration on anatomical terminology study [17].

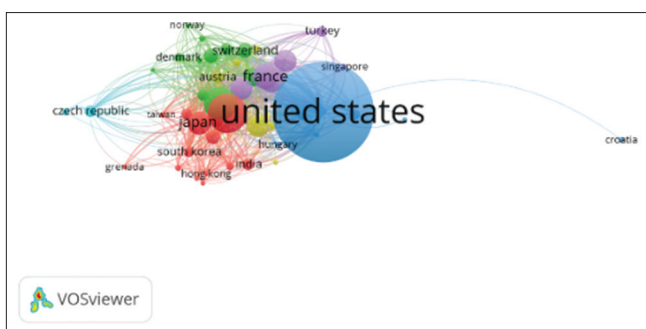


Figure 6: Relation between countries

Of the 159 authors that published articles on the topic of anatomical terminology, the most prolific writer is from Czech Republic and affiliated with Charles University, David Kachlik, contributed to writing 17 publications (2.85%). Then Nuemann, P.E. with 15 publications (2.51%), Anderson, R.H. with 14 publications (2.35%), Rosse, C. with 14 publications (2.51%) and Musil, V. with 13 publications (2.18%). The ten authors who compile the most publications related to anatomical terminology are shown in Figure 7.

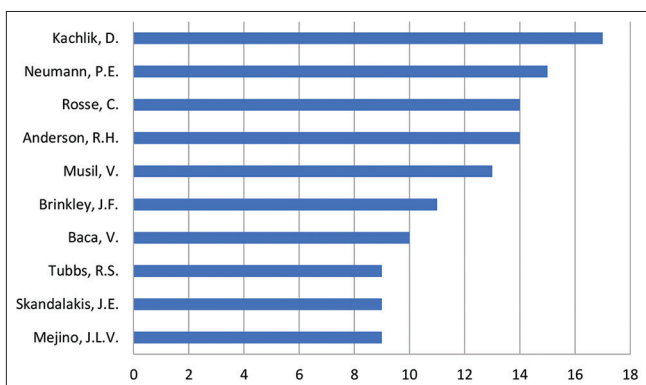


Figure 7: Most prolific author

Figure 8 shows the ten institutions with the highest number of publications on the topic of anatomical terminology. The institution with the highest number of publications is the Universidade de Sao Paulo located in Brazil which publishes 37 publications. Of the ten institutions, seven are located in the United States, three in Brazil, the Czech Republic, and Canada.

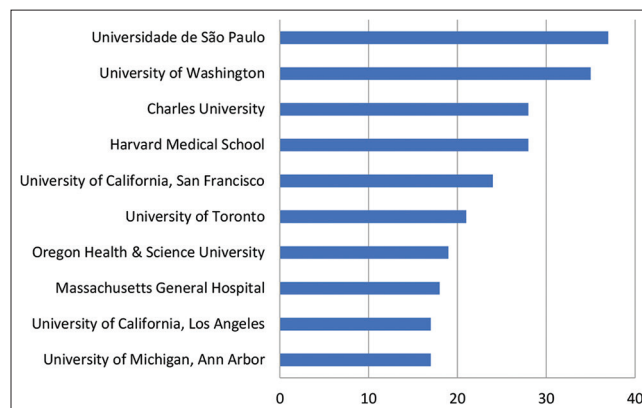


Figure 8: Top 10 institutions based on publication counts

Discussion

Research related to anatomical terminology obtained from the Scopus database from 1914 to 2021 acquired 1821 publications. The number of publications related to anatomical terminology shows an increase in the specified timeframe. In 1990, there were 10 publications related to anatomical terminology, in 2000, there were 29 publications, in 2010, there were 52 publications, and in 2020, there was an increase in publications to 101 publications which was the year with the highest number of publications. This increase can be attributed to the increased flow of information exchange and the need for a standard of anatomical terminology. This increase in the number of publications can also be attributed to the publication of *Terminologia Anatomica* by the FCAT in 1998, which made research on anatomical terminology easier to carry out.

The publications with the highest number of citations are shown in Table 1, all publications in the table are articles with the number of citations above 1000. The publication with the highest number of citations is occupied by the publication titled “The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction” which was published in 1996. This publication is an example of a publication that directly discusses the need for standardization of anatomical terminology, specifically terminology of pelvic organ and pathological abnormalities that occur [17].

Figure 4 in addition to showing the number of occurrences of words also shows the relationship between keywords and cluster of each keyword.

From the bibliometric map formed using VOSviewer application, the keywords were classified into six clusters. Clusters 1 and 2 are arranged with words related to anatomy as a science. Keywords such as “gross anatomy,” “comparative anatomy,” and “morphology,” make up the first cluster while, “anatomy,” “histology,” and “embryology” occupy the second cluster. Clusters 3 and 4 are mostly arranged with keywords related to anatomical terminology. The third cluster is organized with the keywords “*terminologia anatomica*,” “anatomical terminology,” “anatomical nomenclature,” and “latin anatomical terms” which shows keywords from publications related to anatomical terminology. “Nomenclature” and “definition” make up the fourth cluster. In clusters 5 and 6, more keywords related to anatomy as a basis in clinical practice came out. Cluster 5 is composed of keywords such as “diagnosis” and “surgery,” while in cluster 6, there are keywords such as “neuroanatomy,” “spine,” and “cranial nerves.”

Based on the bibliometric map with the overlay display in Figure 5, keyword analysis can be carried out from year to year. On the map created using the VOS viewer application, keyword labels are shown using certain colors. The darker the label means the older it is and vice versa, the lighter the color of the label means that the keyword is newer. Keywords such as “nomenclature,” “homology,” and “comparative anatomy” with blue labels indicate that these topics are no longer widely researched and there are not many publications related to these topics, while keywords such as “new species,” “anatomical terminology,” and “latin anatomical terms” with yellow labels means these topics have been studied a lot recently.

The keywords “anatomical terminology” and “latin anatomical terms” which have been widely published in the past 5 years can be related to the need for revision of the *terminologia anatomica* which was first published in 1998 and revised in 2019. Before *terminologia anatomica*, *nomina anatomica* has been published since 1895, as a means to standardized anatomical terminology, this publication then received six other revisions in 1961, 1966, 1977, 1983, and 1989. In the final revision in 1996, *nomina anatomica* the revised with different name of *terminologia anatomica* that was published in 1998 [6].

The year with the most publications related to anatomical terminology obtained in 2020 which can also be related to the reaction of researchers in the field of anatomy to the publication of TA2 by FIPAT in 2019 [9]. Publications published in 2020 or after the publication of TA2 indirectly aim to provide medical professionals a view on these official anatomical terminology publications [18]. Chmielewski in his publications emphasizes the importance of revisions and extensions of *Terminologia Anatomica* to ensure effective communication. Terminology which is then revised must be published and popularized for professionals to use in their professional activities [10]. The need for clear,

complete, and acceptable terminology by professionals is important to ensure that there is no confusion, misinterpretation, and communication errors [7].

Conclusion

This study provides an overview of the development and trends related to the publication of anatomical terminology. The increasing number of publications from year to year shows that topics related to anatomical terminology are still developing. The keywords “Anatomical Terminology” and “*Terminologia Anatomica*” have also received more attention in the publications of the past 5 years, which shows that publications related to anatomical terminology that are more precise, clear, comprehensive, and acceptable are still being carried out.

Disclaimer

The authors' views expressed in this article are their own and not an official position of the institution or funder.

Author Contribution

All authors contributed equally to this manuscript. All authors read and approved the final manuscript.

References

1. Çan MA, Toraman Ç. The effect of repetition-and scenario-based repetition strategies on anatomy course achievement, classroom engagement and online learning attitude. *BMC Med Educ.* 2022;22:491. <https://doi.org/10.1186/s12909-022-03564-8>
2. Stephens S, Moxham BJ. Gross anatomy examination performances in relation to medical students' knowledge of classical Latin and Greek. *Clin Anat.* 2018;31(4):501-6. <https://doi.org/10.1002/ca.23056> PMID:29396874
3. Moxham B, McHanwell S, Plaisant O, Pais D. A core syllabus for the teaching of neuroanatomy to medical students. *Clin Anat.* 2015;28(6):706-16. <https://doi.org/10.1002/ca.22577>
4. Sangam MR, Praveen K, Vinay G, Bokan RR, Deka R, Kaur A. Efficacy of case-based learning in anatomy. *Cureus.* 2021;13(12):e20472. <https://doi.org/10.7759/cureus.20472>

- PMid:35047293
5. Galic BS, Babovic SS, Vukadinovic S, Strkalj G. Clinical relevance of official anatomical terminology: The significance of using synonyms. *Int J Morphol*. 2018;36(4): 1168-1174. <https://doi.org/10.4067/S0717-95022018000401168>
 6. Ocak M, Aktaş HA, Uzuner MB, Geneci F, Aşkit Ç, Sargon MF. A comparison of the anatomical terminology in the last 25 years. *J Anat Soc India*. 2017;66:S31-3. <https://doi.org/10.1016/j.jasi.2017.09.002>
 7. Temirgazina Z, Akosheva M, Shakaman Y, Shaharman A, Kurmanova Z, Kairova M. Metaphors in anatomical terminology. *Space Culture India*. 2019;7(1):143-53. <https://doi.org/10.20896/saci.v7i1.528>
 8. Chmielewski PP, Domagala ZA. Terminologia anatomica and its practical usage: Pitfalls and how to avoid them. *Folia Morphol (Poland)*. 2020;79:198-204. <https://doi.org/10.5603/FM.a2019.0086>
 9. Kachlik D, Musil V, Blankova A, Marvanova Z, Miletin J, Trachtova D, *et al*. A plea for extension of the anatomical nomenclature: Vessels. *Bosn J Basic Med Sci*. 2021;21(2):208-20. <https://doi.org/10.17305/bjbm.2020.5256>
PMid:33259774
 10. Chmielewski PP, Strzelec B. Should Terminologia Anatomica be revised and extended? A critical literature review. *Folia Morphol (Poland)*. 2020;79(1):1-14. <https://doi.org/10.5603/FM.a2019.0047>
PMid:31025702
 11. Chmielewski PP. New Terminologia Anatomica highlights the importance of clinical anatomy. *Folia Morphol (Poland)*. 2020;79:15-20. <https://doi.org/10.5603/FM.a2019.0048>
PMid:31025701
 12. Bahşi İ, Adanır SS, Kervancıoğlu P, Orhan M, Govsa F. Bibliometric analysis of Turkey's research activity in the anatomy and morphology category from the web of science database. *Eur J Ther*. 2022;27(4):268-80. <https://doi.org/10.5152/eurjther.2021.20108>
 13. El Mohadab M, Bouikhalene B, Safi S. Bibliometric method for mapping the state of the art of scientific production in Covid-19. *Chaos Solitons Fractals*. 2020;139:110052. <https://doi.org/10.1016/j.chaos.2020.110052>
PMid:32834606
 14. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. *J Bus Res*. 2021;133:285-96. <https://doi.org/10.1016/j.jbusres.2021.04.070>
 15. Adanır SS, Bahşi İ, Kervancıoğlu P, Orhan M, Cihan ÖF. Bibliometric analysis of articles published in anatomy, the official publication of the Turkish Society of Anatomy and Clinical Anatomy between 2007-2018. *Anatomy*. 2020;14(1):39-43. <https://doi.org/10.2399/ana.20.019>
 16. Klapka O, Slaby A. Visual analysis of search results in scopus database. In: *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. Germany: Springer Verlag; 2018. p. 340-3. <https://doi.org/10.1007/978-3-030-00066-0-36>
 17. Bump RC, Mattiasson A, Brubaker LP, DeLancey JO, Klarskov P, ShuU BL, *et al*. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol*. 1996;175:10-7. [https://doi.org/10.1016/S0002-9378\(96\)70243-0](https://doi.org/10.1016/S0002-9378(96)70243-0)
PMid:8694033
 18. Neumann PE. Regular anatomical terms revisited: The simplest is often the right one. In: *Clinical Anatomy*. Vol. 34. New Jersey, United States: John Wiley and Sons Inc.; 2021. p. 381-6. <https://doi.org/10.1002/ca.2366>