

A Bibliometric Perspective on the Evolution of Anatomy Theses: Reflections of Changing Scientific Paradigms

Una Perspectiva Bibliométrica Sobre la Evolución de las Tesis de Anatomía: Reflexiones Sobre Paradigmas Científicos Cambiantes

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SUMMARY: This study presents a comprehensive bibliometric analysis of postgraduate anatomy theses published in Turkey between 1969 and 2023. 670 theses obtained through the Council of Higher Education National Thesis Centre were included in the analysis. In the first stage, two anatomists developed thematic categories and subcategories from the summaries of theses using qualitative methods. Then each thesis was recoded based on types of anatomy, materials, methods, systems, regions, and associated disciplines categories. Our results revealed that the most frequently studied anatomical regions were the head (16.42 %) and brain (16.63 %). Gross anatomy emerged as the dominant subfield (34.31 %), followed by clinical anatomy (27.62 %) and experimental anatomy (17.15 %). Neurology, neurosurgery, and orthopaedics were the most commonly associated disciplines with anatomy theses. Radiological images, human cadavers or patients, animal models, and pharmaceutical or herbal substances were the most frequently used materials. Commonly used methods included morphometric analysis, radiological imaging, and histopathological examination. The most studied body systems were the central nervous, locomotor, gastrointestinal, and cardiovascular systems. Notably, only 14 % of theses focused on anatomical variations. Microscopic anatomy, animal anatomy, comparative anatomy, and anatomy education emerged as the least frequently investigated subfields. The sensory organs, endocrine system, lymphatic system, and integumentary system were the least addressed in postgraduate theses. Questionnaires and human intervention-based studies were found to be the least utilised methods. Human fetuses, dry bones, and cell cultures were among the least commonly employed research materials. These findings provide critical insights for anatomy educators, postgraduate students, and clinical researchers by highlighting research patterns changing in time and methodological trends over five decades in order to inform future academic planning and contribute to the strategic development of anatomical research.

KEY WORDS: Anatomy; Bibliometric analysis; Theses.

INTRODUCTION

Hippocrates emphasised the importance of anatomy: “The nature of the body is the beginning of medical science” (Siddiquey *et al.*, 2009). Anatomy is one of the fundamental disciplines of medical science, and in light of the developing science, anatomy has the utmost importance. Throughout history, each researcher has contributed to modern scientific progress with many hypotheses to investigate. The detailed knowledge about the human body always pays attention to its macrostructural, microstructural and functional parts.

Historically, cadaver dissection served as the primary method of anatomical education. However, with advancements in medical science, radiological techniques and experimental models have become integral to anatomical

research and teaching (Petekkaya, 2019). Anatomy, a discipline that investigates morphological and morphometric aspects of the human body, holds a central position in undergraduate medical curricula (Tellioglu *et al.*, 2015). A solid understanding of human structure and function underpins safe and effective clinical decision-making, in alignment with the principle of *primum non nocere*.

The European Union consensus on the teaching of human anatomy states the following goals: (i) to provide a basis for building knowledge in other basic science fields, such as physiology, histology, and pathology, and (ii) to relate expected or standard body structure to function and pathology (Chirculescu *et al.*, 2007). These goals aim to

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ensure that future medical doctors and other healthcare professionals have access to the same background to build their work (Osorio-Toro *et al.*, 2022). Despite its foundational role, anatomy shares particularly close ties with histology. In Turkey, departments of anatomy and histology-embryology were initially united under “morphology” and officially separated in 1988. Nevertheless, this historical overlap continues to influence postgraduate research, as histopathological and physiological methods are frequently integrated into anatomical theses (Hildebrandt, 2019).

The development of radiological imaging and the expansion of neuroscience research have further integrated radiological methods into anatomy, enhancing our ability to visualise, identify, and classify anatomical variations and anomalies (Tellioglu *et al.*, 2015). These advancements have supported the evolution of surgical techniques and improved diagnostic accuracy in clinical settings.

The growing number of students in Turkey’s medical and health sciences faculties has increased the demand for anatomists. Postgraduate education in anatomy is provided through two primary pathways: (i) Master's and Ph.D. programs offered by university institutes of health sciences under the Council of Higher Education (YÖK), and (ii) a residency training program in anatomy for medical doctors (Kundakcı & Ünver, 2022). As one of the graduation requirements, every postgraduate student in Turkey must produce a scientific thesis. And these theses need to be classified and examined using bibliometric methods. A thesis is a central component of postgraduate education, representing original research undertaken for an academic qualification (Cuschieri *et al.*, 2018). In Turkey the Higher Education Council (YÖK) maintains an online, publicly accessible database of postgraduate theses (Gül *et al.*, 2015). Bibliometric analysis is a method used to evaluate scientific production quantitatively, identifying trends, research focuses, and development within a given field. These analyses reveal thematic shifts, research gaps, and evolving priorities and can help guide future studies based on emerging needs and original hypotheses (McBurney & Novak, 2002; Denizli *et al.*, 2024).

Unfortunately, only a limited number of studies have focused explicitly on anatomy theses. Well-executed bibliometric studies are essential for assessing anatomical research volume, direction, and academic contribution (Tellioglu *et al.*, 2015; Adanır *et al.*, 2020). In this context, the present study aims to conduct a comprehensive bibliometric analysis of postgraduate theses—both doctoral and residency—in the field of anatomy in Turkey between 1969 and 2023. Our objective is to identify long-term research trends, methodological patterns, and thematic focuses that have shaped the development of anatomy as an academic discipline.

MATERIAL AND METHOD

This research is a descriptive bibliometric analysis study using qualitative (categorical content analysis) and quantitative methods (frequency tables, co-occurrence analysis). The metadata of all residency and doctoral theses in the anatomy departments of medical faculties in Turkey between 1969 and 2023 were obtained from the National Thesis Centre and included in the study (N=753), and theses with full abstract texts (n=670) were included in the study (CoHE National Thesis Center, 2024). Ethics committee approval was not required because the study used publicly available, non-identifiable thesis metadata obtained from an open database.

The database was created in MS Excel, and the researchers coded each thesis in predefined upper categories (Types of Anatomy, Materials, Methods, Systems of Anatomy, Regions, and Associated disciplines). Also, sub-codes were generated. The types of anatomy used in the theses (e.g., clinical, comparative, gross, microscopic) were identified in the types of anatomy category. In the Materials and Methods categories, the materials used in theses (e.g., human cadaver, photographs, radiological data) and the methods applied (e.g., dissection, human intervention, questionnaire) were coded. Additionally, each thesis was classified based on the Systems of Anatomy, which focuses on (e.g., nervous, circulatory), the Body Region studied in theses, and the Associated Medical Disciplines (e.g., surgery, radiology) relevant to the topic. 83 theses were excluded due to insufficient metadata for classification, and 670 theses were included in the analysis.

Statistical Analysis

Based on the examination of metadata and abstracts, labelling was performed in different categories: Types of Anatomy, Materials, Methods, Systems of Anatomy, Regions and Associated Disciplines. Each thesis received a minimum of one and a maximum of two labels per category. In total, 4,372 labels were assigned. Microsoft Excel was utilised for coding and analysis, while the Flourish platform was employed for data visualisation. For the analysis, the assigned codes' frequencies, percentages, and co-occurrence counts were calculated. Based on these results, interactive online visualisations linked below were created and made publicly accessible to researchers interested in the subject.

Anatomy-Frequencies Graph displays the frequencies of codes across different categories, enabling a general overview of code distributions (<https://public.flourish.studio/visualisation/19625490/>)

Anatomy-Trends Graph represents a trend analysis of the percentage values of codes in theses from 1969 to 2023 across seven anatomical categories. Linear regression was applied to identify the codes with the steepest increasing or decreasing trends over time (<https://public.flourish.studio/visualisation/20050950/>)

Anatomy-Radial Network Graph depicts the frequency of code co-occurrence both within and between categories, using a radial network layout. This allows for a clearer understanding of how often specific codes appear together, offering insights into interdisciplinary and cross-thematic patterns (<https://public.flourish.studio/visualisation/20024679/>)

RESULTS

The distribution of the seven primary categories and their corresponding subcategories used in the thesis analysis is presented in Figure 1, produced via our Anatomy-Frequencies Graph (<https://public.flourish.studio/visualisation/19625490/>), and in Tables I, II-a, and II-b. Figure 1 summarises the distribution of 670 postgraduate anatomy theses conducted in Turkey between 1969 and 2023, categorised by major bibliometric parameters. Each box's proportional size in Figure 1 corresponds to each category's relative frequency, providing a comprehensive visual overview of research trends and focal points in

postgraduate anatomy education in Turkey. The most frequently encountered codes within each category are as follows: In the Methods category, the top three ranks are morphometric measurement (42.52 %), dissection (15.31 %), and histopathological examination (15.19 %). In the Types of Anatomy category, the most prevalent subfields are gross anatomy (34.31 %), clinical anatomy (27.62 %), and experimental anatomy (17.15 %). In the Materials category, the leading sources of data are radiological imaging (18.23 %), experimental animal (17.39 %), and human cadaver studies (17.03 %). In the Associated Disciplines category, the most commonly linked fields are neurology (16.47 %), brain and nerve surgery (14.73 %), and orthopaedics and traumatology (10.31 %). In the Systems of Anatomy category, the most frequently studied systems are the central nervous system (25.40 %), the locomotor system (23.82 %), and the cardiovascular system (12.50 %). In the Regions category, the most commonly examined anatomical regions are the brain (16.63 %), the head (16.42 %), and the neck (5.76 %). Additional insights can be obtained by reviewing the relevant online graph <https://public.flourish.studio/visualisation/19625490/>.

Trends in each category over five decades and the most recent five-year period are summarised in Table III and visualised in Figure 2 (see online graph <https://public.flourish.studio/visualisation/20050950/>). Figure 2 illustrates the chronological evolution of selected

Table I. Frequency rank and percentiles of types of anatomy, systems of anatomy, methods, and materials categories.

Types of Anatomy	%	Systems of Anatomy	%	Methods	%	Materials	%
Gross Anatomy	34.31	Central Nervous System	25.4	Morphometric measurement	42.52	Radiological data	18.23
Clinical Anatomy	27.62	Locomotor System	23.81	Dissection	15.31	Animal (experimental)	17.39
Experimental (physiological)	17.15	Cardiovascular System	12.5	Histopathologic examination	15.19	Human (cadaver)	17.03
Developmental Anatomy	6.42	Peripheral Nervous System	9.72	Radiologic Imaging	10.13	Human (normal)	13.79
Neuroanatomy	5.16	Gastrointestinal System	8.53	Animal experiment	6.48	Human (patient)	12.71
Microscopic Anatomy	3.35	Respiratory System	5.56	Morphologic evaluation	5.65	Drugs, herbals, chemicals	9.83
Animal anatomy	3.21	Urogenital System	5.36	Neuromuscular tests	2.83	Human (fetus)	3.72
Comparative Anatomy	2.23	Multi-system	3.37	Questionnaire	0.82	Human (dry bones)	3.12
Anatomy (medical) education	0.56	Sense organs	2.18	Physiologic examinations	0.71	Animal (non-experimental)	2.88
-	-	Endocrine System	1.79	Retrospective data analysis	0.24	Cell culture	0.96
-	-	Lymphatic System	0.99	Human Intervention	0.12	Photographs	0.36
-	-	Integumentary system	0.79	-	-	-	-

Table II-a. Frequency ranking and percentages of ‘regions’

Regions	%		%
Brain	16.63	Abdominal cavity	0.21 (1 thesis)/ or less
Head	16.42	Abdominal walls	
Neck	5.76	Adrenal glands	
Hand	4.90	Arm	
Foot	3.84	Axilla	
Heart	3.84	Bone	
Knee	3.62	Breast	
Liver	2.99	Cervical plexus	
Orbit	2.99	Cranial nerves	
Vertebral column	2.99	Diaphragm	
Shoulder	2.35	Dorsal muscles	
Thorax	2.35	Cervical part of oesophagus	
Crus	2.56	Thoracic part of oesophagus	
Femoral	2.56	Abdominal part of oesophagus	
Face	1.92	Pterigopalatine fossa	
Nose	1.71	Gallbladder and ducts	
Back /Dorsum	1.71	Hip	
Pelvis	1.49	Large intestines	
Lungs	1.49	Lymph nodes	
Abdomen	1.49	Mediastinum	
Brachial plexus	1.28	Meninx	
Perineum	1.07	Muscle	
Lower limb	0.85	Nerve	
TMJ	0.85	Ovary	
Forearm	0.85	Pancreas	
Prostate	0.64	Penis	
Cubital region	0.64	Peritoneum	
Larynx	0.64	Portal system	
Lumbosacral plexus	0.64	Rectum	
Aorta	0.64	Sacroiliac joint	
Gaster	0.64	Scalp	
Uterus	0.43	Scrotum	
Upper limb	0.43	Skull	
Spinal Cord	0.43	Small Intestines	
Spleen	0.43	Sympathetic trunk	
Ears	0.43	Temporal region	
Kidneys	0.43	Testicles	
Oral region	0.43	Thyroid	
		Ureter	
		Urinary bladder	
		Vagina	

Table II-b. Frequency ranking and percentages of ‘associated disciplines’ category

Associated Disciplines	%	Associated Disciplines	%
Neurology	16.47	Aerospace Medicine	0.13 (1 thesis)/ or less
Brain and Nerve Surgery	14.73	Biology	
Orthopaedics and Traumatology	10.31	Biophysics	
Multi (+3) Disciplines	7.1	Child and Adolescent Mental Health and Diseases	
Physical Medicine and Rehabilitation	6.02	Emergency medicine	
Otorhinolaryngology	4.69	Epigenetics	
Cardiovascular Surgery	3.61	Family medicine	
Urology	3.35	Genetics	
General Surgery	3.35	History of medicine	
Veterinary medicine	3.08	Medical Biochemistry	
Internal Medicine	3.08	Medical Biology	
Ophthalmology	2.4	Medical Ecology and Hydroclimatology	
Gynecology and Obstetrics	2.14	Medical Genetics	
Forensic Medicine	2.01	Medical Microbiology	
Pediatrics	1.87	Medical Pathology	
Cardiology	1.74	Medical Pharmacology	
Sports Medicine	1.61	Mental Health and Diseases	
Thoracic Surgery	1.34	Nuclear medicine	
Psychiatry	1.34	Nursing	
Dentistry	1.34	Physical education and sports	
Chest Diseases	1.20	Physiology	
Plastic, Reconstructive and Aesthetic Surgery	1.07	Physiotherapy and Rehabilitation	
Oncology	0.8	Public health	
Fine arts	0.67	Radiology	
Geriatrics	0.54	Underwater Medicine and Hyperbaric Medicine	
Forensic anthropology	0.54		
Medical Education	0.54		
Anesthesiology and Reanimation	0.4		
Dermatology	0.4		
Histology and Embryology	0.4		
Infectious Diseases and Clinical Microbiology	0.27		

bibliometric variables in postgraduate anatomy theses conducted in Turkey between 1969 and 2023. The graph highlights how anatomical research trends have diversified and become more interdisciplinary in recent decades, reflecting broader shifts in medical science, technological advancement, and methodological preferences. The data reveal both increasing and declining usage of specific codes. Notably, morphometric measurement and clinical anatomy have demonstrated a significant upward trend in recent years, whereas other codes have either remained stable or declined.

A radial network analysis (Fig. 3) was used to explore the co-occurrence of codes across categories (see online graph for radial network analysis <https://public.flourish.studio/visualisation/20024679/>). Figure 3, as a radial network graph, visualises the interrelationships among major bibliometric categories extracted from 670 postgraduate anatomy theses conducted in Turkey between 1969 and 2023. Edges (grey lines) in Figure 3 indicate the co-occurrence of parameters within the same thesis, thereby highlighting anatomical research's multidimensional and interdisciplinary nature. The density and distribution of connections suggest strong thematic linkages, particularly among materials, methods, and clinical disciplines, as well as between anatomical systems and types of anatomy. This visualisation provides a comprehensive overview of how different research components are integrated across studies, reflecting evolving academic priorities, interdisciplinary collaborations, and methodological diversity in the field of anatomy.

In the Types of Anatomy category, gross anatomy (n = 246), clinical anatomy (n = 198), and experimental (physiological) anatomy (n = 123) were the most frequently classified subcategories.

Gross anatomy theses were most frequently associated with brain and nerve surgery (n = 48) and orthopaedics and traumatology (n = 38). Clinical anatomy was strongly linked with neurology (n = 41), brain and nerve surgery (n = 28), orthopaedics (n = 28), and physical medicine and rehabilitation (n = 26).

Regarding materials, gross anatomy was mainly paired with human cadavers (n = 102), radiological data (n = 73), and normal human (n = 59). Clinical anatomy theses were most frequently associated with patients (n = 86), radiological data (n = 72), and normal human (n = 42).

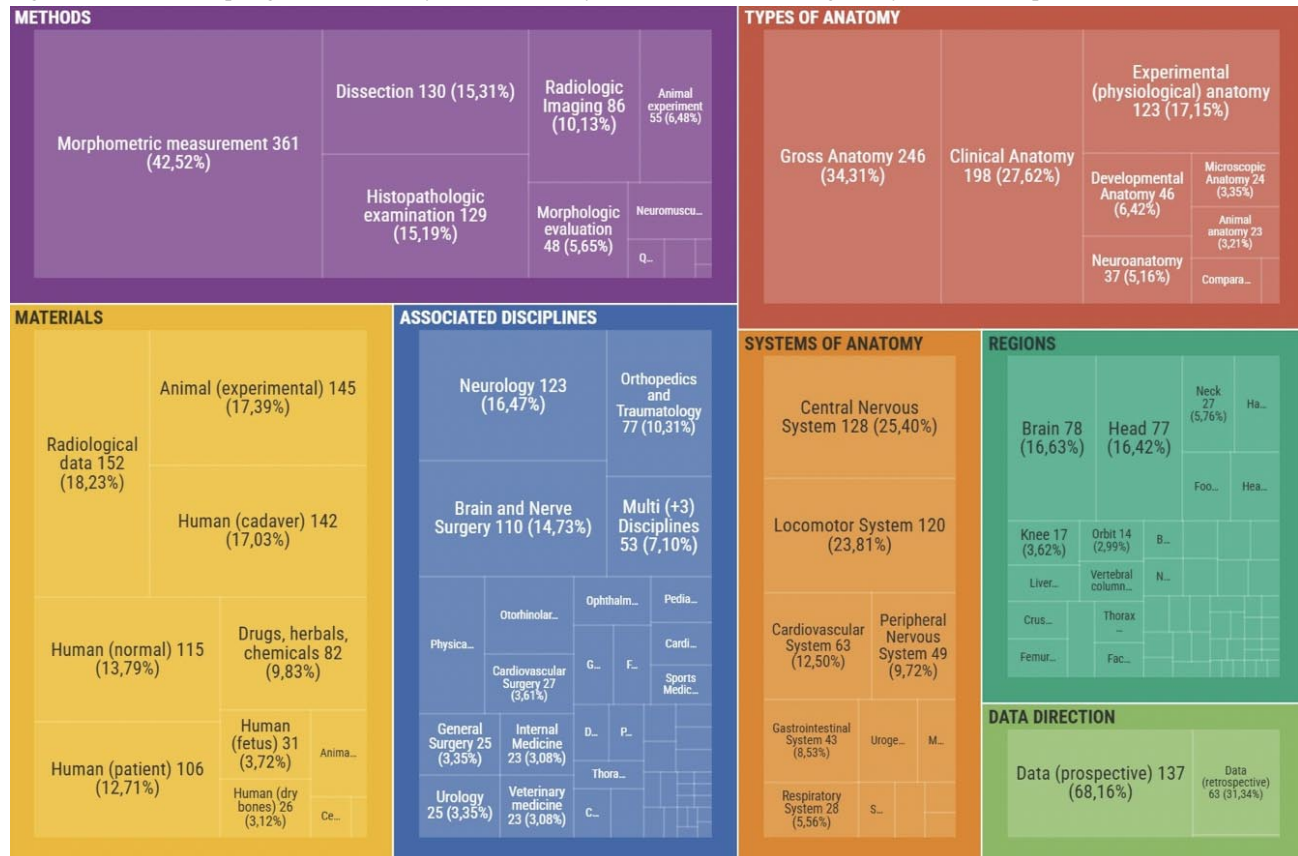
Table III. Frequency trends and linear regression slope values of codes in 5 decades and 5 years (1969- 2023). Positive values indicate an increase in code frequency, while negative values indicate a decrease over time

Category	Code with max. slope	Code with min. slope
Types of anatomy	Clinical Anatomy (Slope: 28,00)	Neuroanatomy (Slope: -0.90)
Systems of Anatomy	Central Nervous System (Slope: 11,20)	Cardiovascular System (Slope: -0.50)
Regions	Head (Slope:8,40)	Orbit (Slope: -2,50)
Methods	Morphometric measurement (Slope: 28,20)	Physiological examinations (Slope: -0.20)
Materials	Human (patient) (Slope:19,20)	Photographs (Slope:0,33)
Data Direction	Data (prospective) (Slope:9,11)	Data (retrospective) (Slope:9,10)
Associated disciplines	Neurology (Slope: 12,10)	Dermatology (Slope: -1.00)

In the methods category, gross anatomy theses were most frequently linked with morphometric measurement (n = 175), dissection (n = 83), and morphologic evaluation (n = 32), while clinical anatomy theses mainly were associated with morphometric measurement (n = 139) and radiologic imaging (n = 49).

Theses classified as experimental anatomy, one of the subcategories of the Types of anatomy category, were most frequently matched with the histopathologic examination (n=91). Theses classified in gross anatomy were most frequently matched with the locomotor system (n=57), cardiovascular system (n=28), and central nervous system (n=25) variables situated in the anatomy systems category, respectively. The theses in the clinical anatomy code were

Fig. 1. Distribution of postgraduate anatomy theses in Türkiye (1969–2023) according to key bibliometric parameters.



most frequently paired with the locomotor system (n=44) and the central nervous system (n=41), respectively. These classified in both the experimental anatomy and neuroanatomy subcategories were most frequently matched with the central nervous system code.

When thesis topics were classified according to systems, the central nervous system (CNS) (n = 128) and locomotor system (n = 121) were found to be the most studied. The methods that were used most were morphometric measurement (n=60), histopathologic

examination (n=36), and radiologic imaging (n=26) in the theses that investigate the CNS. The most used method was morphometric measurement (n=83) in the thesis investigating the locomotor system.

When the regions category was considered, the frequently studied regions were the brain (n=84), head (n=81), and neck (n=33), respectively. Both brain and head were commonly associated with radiological data of the materials category and with morphometric measurement of the methods category (Fig. 3).

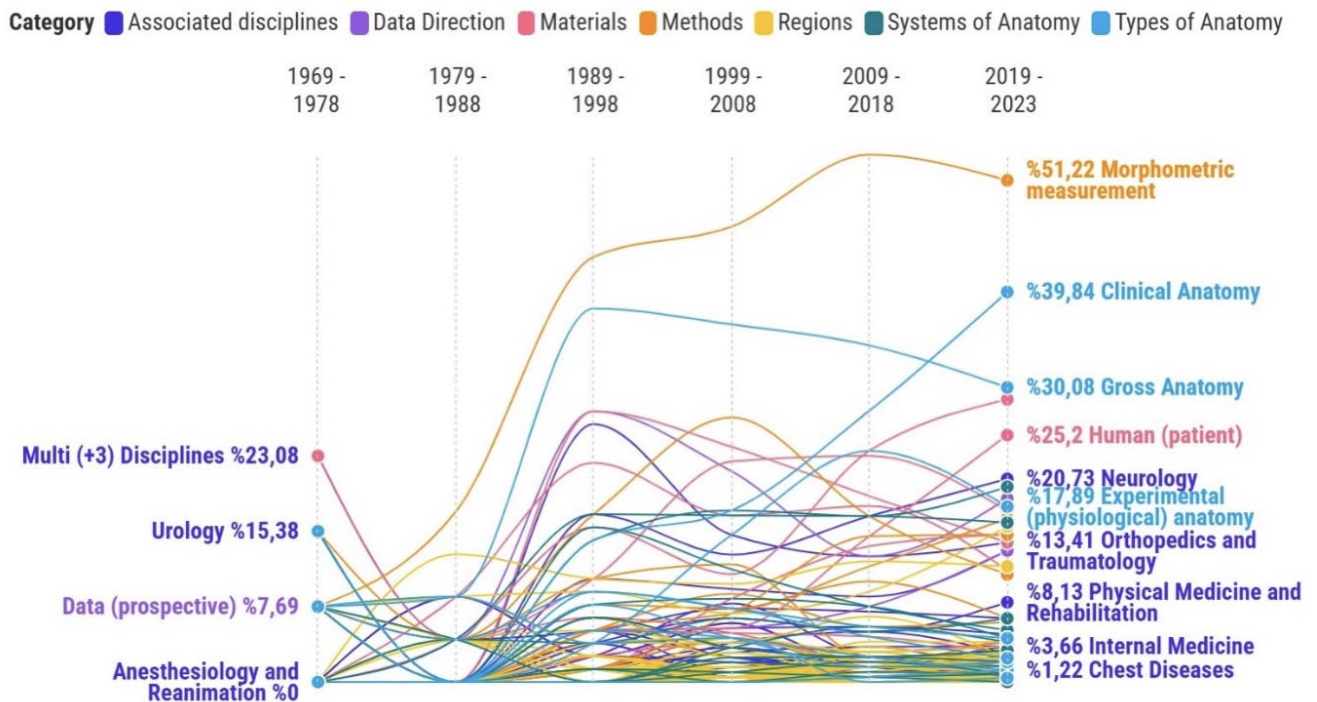


Fig. 2. Temporal trends in postgraduate anatomy theses in Türkiye (1969–2023) based on key bibliometric parameters.

DISCUSSION

In light of the developments in science and technology, the thematic focus and methodological approaches within anatomical research have evolved significantly. Despite its foundational role, bibliometric studies examining postgraduate theses in anatomy—particularly in Turkey—remain scarce. This study aims to fill this gap by presenting a comprehensive bibliometric analysis of doctoral and medical specialisation theses in the field of anatomy in Turkey.

Among the 670 theses analysed, doctoral theses (n = 474; 70.7 %) considerably outnumbered medical specialisation theses (n = 196; 29.3 %). This disparity is likely due to the broader eligibility criteria of doctoral programs, which are open to graduates from various health-

related disciplines. In contrast, medical specialisation programs are restricted to medical doctors. Supporting this observation, Kundakcı & Ünver (2022) reported that only 14.6 % of thesis authors between 2016 and 2020 were medical doctors, with the majority being physiotherapists (42.8 %), biologists (16.4 %), and nurses (14.9 %). Similarly, Çetkin *et al.* (2016) found that medical graduates were underrepresented in postgraduate anatomy programs.

Classifying thesis topics and methodologies is similar to previous literature, but broader. For example, a bibliometric analysis of 214 articles published in ‘The Journal of Anatomy’ categorised studies from most to least common as follows: experimental animal studies, radiological studies, clinical studies, cadaveric studies, dry

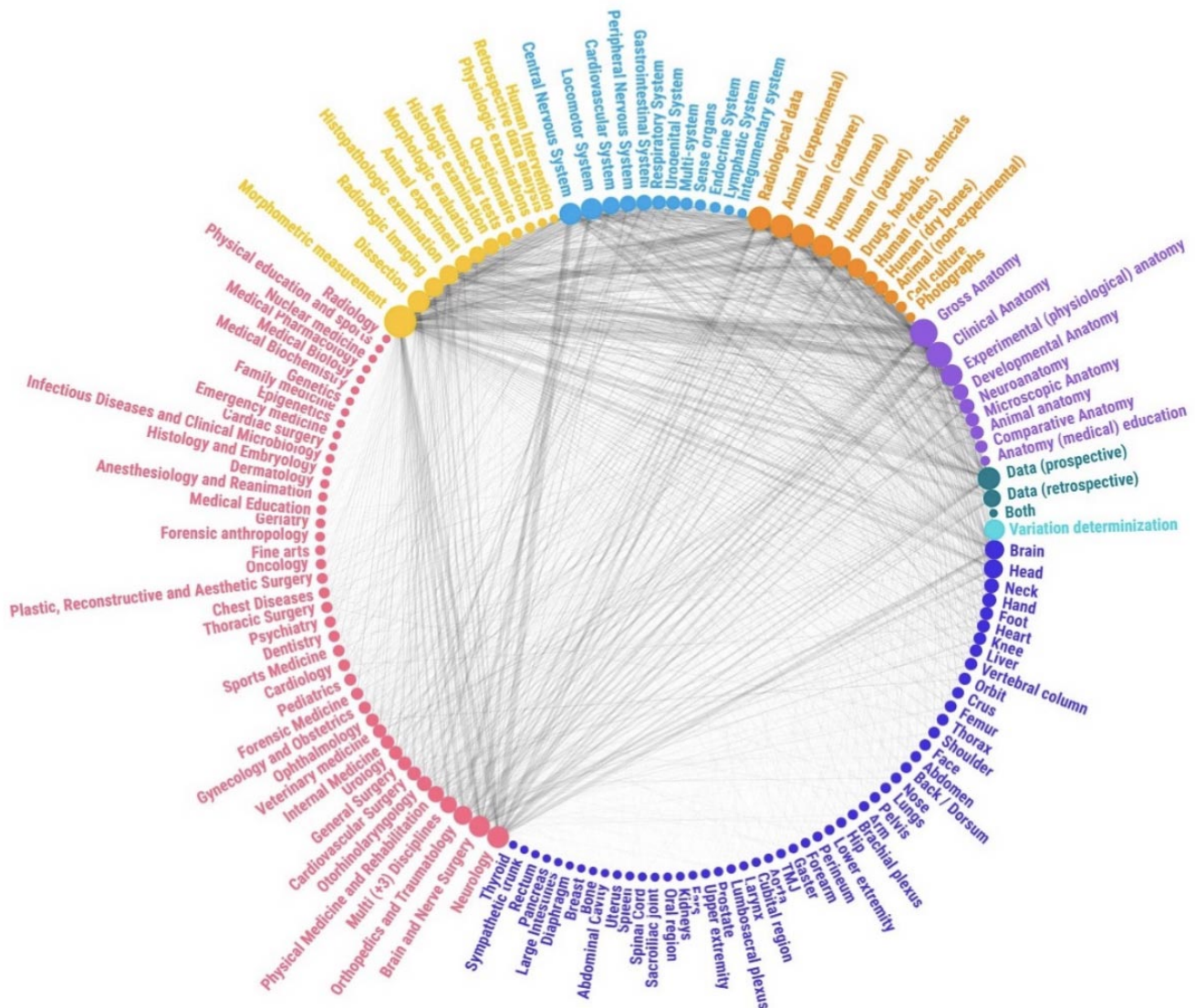


Fig. 3. Radial Network Visualisation of Thematic Relationships in Postgraduate Anatomy Theses (Türkiye, 1969–2023).

bone studies, histological studies, and fetal studies (Adanır *et al.*, 2020). While our classification is consistent with this framework, it offers a more detailed and nuanced categorisation.

Similarly, Demir *et al.* (2023) reported that the dominant topics in anatomy were radiological studies (39.3 %), anthropometric studies (20.3 %), cadaver studies (19.4 %), experimental animal models (14.9 %), clinical studies (2.7 %), survey studies (1.8 %), etc. when they analysed 557 master's theses. In contrast, our study focused only on doctoral and specialist theses. We classified the theses in terms of material into radiological data, cadaver and experimental animal studies in the materials category, but the codes such as gross anatomy, clinical anatomy and experimental anatomy in the types of anatomy category.

Although there are similarities with Demir *et al.* (2023), our results also show significant differences, especially in the depth of classification (Fig. 3).

The educational and clinical relevance of human anatomy has been emphasised in numerous studies. Drake *et al.* (2004) underlined its critical function in medical curricula, while Osorio-Toro *et al.* (2022), advocated for the integration of basic and clinical sciences to enhance learning efficacy. Clinical and cadaver-based anatomy studies have been shown to attract more citations, suggesting their scientific and educational value (Adanır *et al.*, 2020). Integrating radiological imaging and clinical content into anatomy education significantly improves conceptual understanding and clinical interpretation skills (Hu *et al.*, 2018).

In line with this trend, Toy & Sahin (2022) reported a notable increase in clinical anatomy-focused doctoral theses after 2010. Our findings corroborate this shift, as we observed a consistent and accelerating rise in clinical anatomy theses between 1989 and 2023 (Fig. 2). This trend reflects a broader effort to align anatomical education more closely with clinical practice.

Several previous studies have evaluated methodological trends in anatomy theses. Karabas *et al.* (2022) found that, between 2007 and 2017, cadaver studies (40.4 %) were the most common, followed by radiological (29.8 %) and experimental animal studies (22.8 %). Interestingly, in a subsequent study analysing 148 doctoral theses from 2009 to 2019, radiological methods (33.8 %) surpassed cadaveric (22.3 %) and experimental animal models (27 %) (Karabas & Dag, 2024). Our broader dataset spanning 1969–2023 shows that morphometric measurements (42.5 %) were the most common method, followed by dissection (15.3 %), histopathological examination (15.2 %), and radiological imaging (10.1 %) (Fig. 1).

Experimental animal studies have gained increasing prominence in anatomy research. These studies contribute to biomedical knowledge and support the development of disease models that enhance diagnostic and therapeutic procedures (Ozkan, 2020). Technological advancements in laboratory infrastructure have facilitated more complex experimental designs. Toy & Sahin (2022) observed a statistically significant increase in experimental doctoral theses post-2010, a trend echoed in our findings. Animal studies are a commonly employed research design not only in anatomy but across various scientific disciplines. Experimental Animal Studies are included in the literature with a high percentage in international anatomy publications originating from Turkey (Bahsi *et al.*, 2021). A bibliometric study analysing neurosurgery speciality theses completed in Turkey between 2015 and 2019 found that the most frequently used type of experimental study in both published and unpublished theses was animal experimentation (Bahadır & Basar, 2023). We found animal experiments to be the 3rd in the ‘types of anatomy’ category as experimental anatomy (Fig. 1).

Radiological techniques have become indispensable in anatomy research and education, offering high accuracy and repeatability compared to traditional anthropometric methods (Guyomarch & Bruzek, 2011). Besides, technological tools such as VolBrain, MRICloud, and ImageJ are increasingly used in neuro-morphometric studies (Yilmaz *et al.* 2020). Nowadays, the use of ultrasonography (USG) in anatomy education is discussed, and the need for

radiological methods to be more effectively included in both undergraduate and graduate anatomy education programs is emphasised (Pushpa & Ravi, 2024). Radiological anatomy now stands as a key pillar of clinical anatomy instruction. Toy & Sahin (2022) reported that radiological images are used in thesis studies in an integrated manner with anthropometric measurements, disease-based examinations or cadaveric images. Toy & Sahin (2022) reported a post-2010 increase in radiologic anatomy theses alongside a decline in anthropometric methods, a pattern we also observed. Kundakcı & Ünver (2022) reported that radiological methods were the most frequently used method in thesis designs (43.3 %), followed by experimental animal studies (18 %) and anthropometric studies (11.8 %). We measured the use of radiology in the materials category both prospectively and retrospectively within radiologic data and found it to be the most frequent variable in the materials category (Fig. 1).

The use of human cadavers has long been considered a cornerstone of anatomical education, particularly at the undergraduate level. Numerous studies underscore the pedagogical advantages of dissection, emphasising its critical role in helping students understand three-dimensional anatomical relationships and spatial orientation (Karabas *et al.*, 2022). In Turkey the incorporation of cadaver-based training dates back to 1908, following the formal adoption of cadaver fixation methods (Hu *et al.*, 2018). However, in recent decades, the sustainability of dissection-based education has come under scrutiny due to multiple challenges, including cadaver shortages, procurement difficulties, and increasing financial costs (Estai & Bunt, 2016). Our analysis of 670 postgraduate theses revealed that cadaver use, categorised under the "human cadaver" code in the material subcategory, ranked third overall, comprising 17 % of the total material types used. This relatively modest proportion suggests that cadaver-based research is becoming less prevalent, a finding consistent with broader trends in anatomical education. Multiple factors likely contribute to this decline, including logistical obstacles in cadaver acquisition, limited availability of cadaveric material across universities, and the labour-intensive, cost-prohibitive nature of cadaver-based studies (Demir *et al.*, 2023).

Although dissection is widely acknowledged as offering unique educational benefits, it is also regarded as technically demanding and resource-intensive (Osorio-Toro *et al.*, 2022). As a result, many postgraduate researchers opt for alternative methodologies such as radiological imaging, digital modelling, or experimental animal models, which are often more accessible and less costly. Toy & Sahin (2022) observed a marked decline in the number of cadaver-

and anthropometry-based doctoral theses after 2010, coinciding with a significant increase in studies employing radiological and clinical techniques. These shifts appear to reflect both technological advancements and evolving institutional preferences.

Interestingly, while the use of cadavers in doctoral theses has generally declined, Karabas *et al.* (2022), in their evaluation of specialisation theses, reported that cadaver-based studies remained the most commonly employed method, accounting for 40.4 % of theses. This discrepancy may be attributed to differences in institutional policies, access to resources, and the specific research objectives of medical specialisation programs. In our study, although a slight upward trend in cadaver-based theses was observed in recent years, their relative prominence declined after 2010, dropping from the most preferred method to the fourth-ranked position in the 2011–2021 period.

Despite these challenges, cadaver studies continue to play a vital role in postgraduate anatomy education, particularly in revealing the morphological and morphometric features and anatomical variations that cannot be fully appreciated through non-invasive techniques. Preserving the role of cadaver-based research while integrating modern technologies may represent the most balanced approach to maintaining the rigour and relevance of anatomical science.

When anatomical systems were analysed, our results differed slightly from those of Kundakcı & Ünver (2022), who found the locomotor (44.9 %), nervous (20.3 %), and cardiovascular systems (8.5 %) to be most frequently studied, respectively. However, in our study, the central nervous system (25.4 %) ranked first, followed by the locomotor (23.8 %) and cardiovascular systems (Fig. 1). Regarding anatomical regions, we found the brain, head, neck, and hand as the most frequently examined areas, which partially aligns with Kundakcı & Ünver (2022) classification which has a rank like head (32.3 %), lower limb (16.7 %) and upper limb (12.1 %) (Fig. 1).

The frequency order and percentages of all categories examined in our study are presented in Table I, Table II-a, and Table II-b. The least frequent category items in our study can be summarised as follows. In terms of anatomy types, microscopic anatomy, animal anatomy, comparative anatomy, and anatomy education are the least studied anatomy types. While the least studied systems in theses were the sensory organs, endocrine system, lymphatic system, and integumentary system, the least studied method types in anatomy theses were questionnaires, physiologic examinations, and human interventions. Lastly, the least used material types in theses were human fetuses, dry bones, cell

culture, and photographs. As a conclusion, further study of these least-studied areas should be recommended.

Bibliometric studies investigating theses and similar academic works at the international level do exist. For instance, in the field of radiology, a bibliometric analysis focused on Spanish doctoral theses has been documented (Machan & Sendra Portero, 2018). In general surgery, a descriptive bibliometric study analysing 739 theses originating from Tunisia has also been reported (Azzaza *et al.*, 2022). In this Tunisian study, the vast majority of general surgery theses (97.5 %) were categorised as either descriptive studies or case reports. The most frequently addressed research topics were emergencies (41 %), common surgical pathologies (26 %), and digestive oncology (21.5 %) (Azzaza *et al.*, 2022).

While most thesis titles and abstracts in our dataset appropriately reflected their content, a small number lacked clarity or brevity. In the theses examined, it was rarely found that the thesis titles did not reflect the content sufficiently. Similarly, when the thesis summaries were evaluated, it was observed that a small number of thesis summaries were written longer than necessary. We propose that an international standardised, systematic, internet-based coding system—such as the one developed for this study—can enhance the accessibility, clarity, and international comparability of thesis data. However, the majority of the theses we examined were able to reflect their content scientifically and comprehensively.

Specifically, the authors of that Tunisian study highlighted the lack of clarity in reporting statistical elements such as confidence intervals and standard deviations, as well as the inadequate selection of keywords (Azzaza *et al.*, 2022). In our study, similar inadequacies in a limited number of thesis abstracts occurred. This common problem, reported as inadequacy in abstract writing by researcher Azzaza *et al.* (2022) and also seen in our study, may likewise be attributed to poor advisor-student communication or suboptimal time management during the thesis-writing process.

Anatomy constitutes a fundamental discipline that is interconnected with all branches of medicine. For example, in a bibliometric analysis of the 100 most-cited rhinoplasty articles published between 1864 and 2015, Sinha *et al.* (2016), reported that seven of these 100 publications were focused specifically on anatomical content. The multidisciplinary nature and impact of anatomy have been further illustrated in a bibliometric study assessing the contribution of anatomists to scientific literature. According to Álvarez *et al.* (2014), only 22.23 % of the articles authored by anatomists between 2007 and 2012 were published in journals indexed under the “Anatomy and Morphology” category in the Journal Citation

Reports (JCR), whereas 77.77 % appeared in journals from other scientific domains (Álvarez *et al.*, 2014). This study concluded that the scientific contributions of anatomists are both quantitatively and qualitatively significant, with most publications appearing in the fields of Neuroscience, Anatomy & Morphology, Cell Biology, and Biology (Álvarez *et al.*, 2014). The authors emphasised that interdisciplinary collaborations enhance scientific progress across numerous areas of research (Álvarez *et al.*, 2014). In light of these literature opinions, it is evident that bibliometric studies focusing exclusively on anatomy theses at the international level remain exceedingly rare.

CONCLUSION

This comprehensive bibliometric analysis of 670 postgraduate theses in anatomy from Turkey, spanning over five decades (1969–2023), reveals significant trends in anatomical research topics and methodologies. The findings demonstrate a progressive shift from traditional cadaver-based and anthropometric studies toward radiological, morphometric, and clinically oriented research. This transition reflects broader developments in medical science, particularly the integration of imaging technologies and interdisciplinary approaches into anatomical investigation.

The analysis of an extensive dataset spanning more than five decades offers critical insights into the historical development and evolving landscape of anatomical research and education. The employed coding model and visualisation tools constitute a valuable asset for researchers, educators, and policymakers, enabling the assessment of current trends and the formulation of future strategies in the field. The interactive visualisations and systematic classifications presented in this study serve as a foundational reference for identifying research gaps and highlighting emerging thematic areas. Notably, this study introduces a systematic, interactive, and reproducible framework for evaluating academic productivity within the anatomical sciences.

Finally, the frequent intersection of anatomy with fields such as radiology, histology, and physiology in postgraduate theses underscores the need for interdisciplinary training in postgraduate education. These findings support the notion that anatomy, while a foundational discipline, continues to adapt to contemporary scientific and educational needs. We recommend the inclusion of compulsory clinical and laboratory rotations in postgraduate anatomy programs to strengthen academic and professional competencies. Given the foundational role of anatomy in medical education and its growing integration with clinical disciplines, enhancing collaboration across departments should be a priority for future educational reforms.

In light of these results, we recommend fostering closer integration between anatomy and clinical disciplines at the postgraduate level, expanding training in advanced radiologic and digital techniques, and developing national strategies to overcome limitations in cadaver access. Strengthening such academic and technical infrastructures will contribute to training anatomists who are well-versed in classical knowledge and equipped for the challenges of modern biomedical science.

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BAYLAN, H.; UÇAR, A. & DEMIRCI, N. Una perspectiva bibliométrica sobre la evolución de las tesis de anatomía: Reflexiones sobre paradigmas científicos cambiantes. *Int. J. Morphol.*, 44(2):588-598, 2026.

RESUMEN: Este estudio presenta un análisis bibliométrico exhaustivo de las tesis de anatomía de posgrado publicadas en Turquía entre 1969 y 2023. Se incluyeron en el análisis 670 tesis obtenidas a través del Centro Nacional de Tesis del Consejo de Educación Superior. En la primera etapa, dos anatomistas desarrollaron categorías temáticas y subcategorías a partir de los resúmenes de las tesis utilizando métodos cualitativos. Luego, cada tesis se recodificó en función de los tipos de anatomía, materiales, métodos, sistemas, regiones y categorías de disciplinas asociadas. Nuestros resultados revelaron que las regiones anatómicas estudiadas con mayor frecuencia fueron la cabeza (16,42 %) y el cerebro (16,63 %). La anatomía macroscópica emergió como el subcampo dominante (34,31 %), seguida de la anatomía clínica (27,62 %) y la anatomía experimental (17,15 %). La neurología, la neurocirugía y la ortopedia fueron las disciplinas más comúnmente asociadas con las tesis de anatomía. Las imágenes radiológicas, los cadáveres o pacientes humanos, los modelos animales y las sustancias farmacéuticas o herbales fueron los materiales más utilizados. Los métodos más utilizados incluyeron el análisis morfométrico, las imágenes radiológicas y el examen histopatológico. Los sistemas corporales más estudiados fueron los sistemas nervioso central, musculoesquelético, el digestivo y cardiovascular. Cabe destacar que solo el 14 % de las tesis se centraron en las variaciones anatómicas. La anatomía microscópica, la anatomía animal, la anatomía comparada y la educación anatómica surgieron como los subcampos menos investigados. Los órganos sensoriales, las glándulas endocrinas, el sistema linfático y el integumento común fueron los menos abordados en las tesis de posgrado. Los cuestionarios y los estudios basados en intervenciones humanas resultaron ser los métodos menos utilizados. Los fetos humanos, los huesos secos y los cultivos celulares se encontraban entre los materiales de investigación menos empleados. Estos hallazgos brindan información crucial para docentes de anatomía, estudiantes de posgrado e investigadores clínicos al destacar los patrones de investigación que cambian con el tiempo y las tendencias metodológicas a lo largo de cinco décadas, con el fin de

informar la planificación académica futura y contribuir al desarrollo estratégico de la investigación anatómica.

PALABRAS CLAVE: Anatomía; Análisis bibliométrico; Tesis.

REFERENCES

- Adanır, S. S.; Bahsi, I.; Kervancıoğlu, P.; Orhan, M. & Cihan, Ö. F. Bibliometric analysis of articles published in Anatomy, the official publication of the Turkish Society of Anatomy and Clinical Anatomy between 2007-2018. *Anatomy*, 14(1):39-43, 2020.
- Álvarez, P.; Boulaiz, H.; Vélez, C.; Rodríguez-Serrano, F.; Ortiz, R.; Melguizo, C.; Ramírez-Tortosa, M. C. & Aránega, A. Qualitative and quantitative analyses of anatomists' research: evaluation of multidisciplinary and trends in scientific production. *Scientometrics*, 98:447-56, 2014.
- Azzaza, M.; Mabrouk, G. B.; Chebil, D.; Nouira, S.; Melki, S.; El Haddad, N. & Abdelaziz, A. B. Forty-year Tunisian bibliometrics of general surgery theses in the four national faculties of medicine (1980-2019). *Libyan J. Med.*, 17(1):2009100, 2022.
- Bahadır, S. & Basar, I. A study on neurosurgery specialty theses and their publication status in international journals. *Med. J. Bakirkoy*, 19(1):97-103, 2023.
- Bahsi, I.; Adanır, S. S.; 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.*, 27(4):268-80, 2021.
- Çetkin, M.; Turhan, B.; Bahsi, I. & Kervancıoğlu, P. The opinions of medicine faculty students about anatomy education. *Gaziantep Med. J.*, 22(2):82-8, 2016.
- Chirculescu, A. R. M.; Chirculescu, M. & Morris, J. F. Anatomical teaching for medical students from the perspective of European Union enlargement. *Eur. J. Anat.*, 11(S1):63-5, 2007.
- CoHE National Thesis Center. *Theses Database*. Website. Ankara, Yükseköğretim Kurulu, 2024. Available from: <https://tez.yok.gov.tr/>
- Cuschieri, S.; Grech, V. & Savona-Ventura, C. WASP (Write a Scientific Paper): how to write a scientific thesis. *Early Hum. Dev.*, 127:101-5, 2018.
- Demir, M.; Karabas, S. A.; Subas, F. B. & Yoldas, A. Evaluation of Master's Thesis Topics of The Faculty of Medicine Department of Anatomy. *KSU Med. J.*, 18(3):22-8, 2023.
- Denizli, Y.; Uçar, A.; Uçar, M. T. & Tunca, M. Y. Bibliometric analysis of PhD, residency dissertations and master's theses in public health departments in Türkiye between 1970 and 2022. *ESTÜDAM Halk Sağlığı Derg.*, 9(2):142-53, 2024.
- Drake, R.; Vogl, A. W. & Mitchell, A. W. M. *Gray's Anatomy for Students*. 2nd ed. Amsterdam, Elsevier, 2004.
- Estai, M. & Bunt, S. Best teaching practices in anatomy education: a critical review. *Ann. Anat.*, 208:151-7, 2016.
- Guyomarc'h, P. & Bruzek, J. Accuracy and reliability in sex determination from skulls: a comparison of Fordisc® 3.0 and the discriminant function analysis. *Forensic Sci. Int.*, 208(1-3):180.e1-6, 2011.
- Gül, I.; Yesiltas, A. & Keklik, B. Sağlık Yönetimi lisansüstü programlarında yapılan tezlerin profili-profile of the thesis made in health management postgraduate programs. *Mehmet Akif Ersoy Üniv. Sos. Bilim. Enst. Derg.*, 1(13):231-44, 2015.
- Hildebrandt, S. The role of history and ethics of anatomy in medical education. *Anat. Sci. Educ.*, 12(4):425-31, 2019.
- Hu, M.; Watchow, D. & Fontgalland, D. From ancient to avant-garde: a review of traditional and modern multimodal approaches to surgical anatomy education. *ANZ J. Surg.*, 88(3):146-51, 2018.
- Karabas, S. A. & Dag, S. S. Evaluation of publishing status of doctoral theses of faculty of medicine department of anatomy in scientific journals. *Med. Rec.*, 6(1):115-9, 2024.

- Karabas, S. A.; Yoldas, A. & Demir, M. Evaluation of the publication status of dissertations of the faculty of medicine anatomy department in scientific journals. *Ann. Med. Res.*, 29(4):329-33, 2022.
- Kundakçı, Y. E. & Ünver, N. Examination of theses on anatomy in the field of basic medical sciences (2016-2020). *Genel Tıp Derg.*, 32(2):182-9, 2022.
- Machan, K. & Sendra Portero, F. Doctoral theses in diagnostic imaging: a study of Spanish production between 1976 and 2011. *Radiologia (Engl. Ed.)*, 60(5):394-403, 2018.
- McBurney, M. K. & Novak, P. L. *What is bibliometrics and why should you care?* Proc. IEEE Int. Prof. Commun. Conf., 2002. Available from: <https://ieeexplore.ieee.org/document/1049094>
- Osorio-Toro, S.; Rodríguez-Campo, A. & Ramirez-Malule, H. Bibliometric analysis of global research output on teaching and learning of human anatomy. *Int. J. Morphol.*, 40(3):789-795, 2022.
- Ozkan, K. Experimental epilepsy models in laboratory animals. *IDUHES*, 3:38-51, 2020.
- Petekkkaya, E. The most cited articles in anatomy: an update study. *Biomed. J. Sci. Tech. Res.*, 22(5):16486-94, 2019.
- Pushpa, N. B. & Ravi, K. S. From cadavers to scans: the evolution of anatomy teaching with imaging. *Natl. J. Clin. Anat.*, 13(3):105-7, 2024.
- Siddiquey, A. K. S.; Husain, S. M. S. & Laila, S. Z. H. History of anatomy. *Bangladesh J. Anat.*, 7(1):1-3, 2009.
- Sinha, Y.; Iqbal, F. M.; Spence, J. N. & Richard, B. A bibliometric analysis of the 100 most-cited articles in rhinoplasty. *Plast. Reconstr. Surg. Glob. Open*, 4(7):e820, 2016.
- Tellioglu, A. M.; Karakas, S. & Polat, A. G. A Survey of Scientific Publications in the Field of Anatomy Conducted in Turkey during 2000–2014. *Meandros Med. Dental J.*, 16(1):1-3, 2015. <https://izlik.org/JA87PN72DA>.
- Toy, S. & Sahin, N. E. An analysis on the evaluation of subjects of doctoral theses completed in anatomy department in Turkey. *Med. Sci. Int. Med. J.*, 11(1):204-7, 2022.
- Yılmaz, S.; Tokpınar, A.; Acer, N.; Degirmencioglu, L.; Ates, S. & Gray, S. B. Evaluation of cerebellar volume in adult Turkish male individuals: comparison of three methods in magnetic resonance imaging. *Erciyes Med. J.*, 42(4):405-10, 2020.

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