

Clinical Neurology Research Output From Türkiye: A Bibliometric Analysis

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ABSTRACT

Introduction: Bibliometric analysis is a comprehensive method used to investigate the academic impact and characteristics of publications in a research field. It has been widely used in various fields of medicine. However, bibliometric analysis of publications in the field of clinical neurology from Türkiye has not yet been evaluated. In this study, we aimed to analyze the publications in the field of clinical neurology in the last decade from Türkiye using the bibliometric method and network analysis and to determine research trends and key issues.

Methods: We carried out a search of the Web of Science Core Collection database for articles. CiteSpace Advances 6.1. R 1 and VOSviewer (version 1.6.9) were used for bibliometric analyses and visualization.

Results: The research data consisted of 8404 articles in the category of the clinical neurology from Türkiye between 2012 and 2022. The number of publications rose over time, with a mean annual growth rate of 6%.

From the document co-citation analysis, chronic migraine and mental health clusters were active current areas. From the keywords analysis, endovascular treatment, depression, oxidative stress, Parkinson's disease, epilepsy, multiple sclerosis, and ischemic stroke were active clusters. Analysis of the authors showed that the most active authors were Betül Baykan, Cavit Boz, and Erdem Tuzun, and MS was the most active topic in this area and recent trend.

Conclusions: Clinical neurology is a rapidly expanding research area and attracting more and more attention from the authors. Our study can provide researchers who study the clinical neurology with valuable information on the current status and trends in this field and to facilitate for future studies.

Keywords: Bibliometric analysis, citespace, clinical neurology, research output, Türkiye, VOSviewer

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INTRODUCTION

Neurological disorders are one of the most common disorders with a high burden on the affected persons, their families, and society. The incidence and prevalence of neurological disorders are increasing owing to an aging population (1). Research on neurological diseases has a profound impact on public health and quality of life (2).

Bibliometric analysis is a quantitative method to investigate the effects of journals, researchers, institutions, or countries. It depends on bibliometrics which is the application of mathematical and statistical methods to articles, journals, books, or other communication media. It enables researchers to assess the scientific outputs produced by individuals or institutions on specified topics within chosen regions and periods and also enables the evaluation of links between these outputs and scientific efficiency. Thanks to bibliometric analysis, researchers can access information more quickly and accurately, and determine the quality of scientific studies in the field of analysis and their contribution to the field. In addition, it can provide guiding information about the fields of interest of researchers working in a particular discipline, their study methodologies, and future trends, as well as clues about their fields of study. Owing to this information, researchers can see the gaps in the

Highlights

- First bibliometric analysis of clinical neurology research output from Türkiye.
- Multiple sclerosis was the most active topic in this field and a recent trend.
- Clinical neurology is a rapidly expanding research field.

relevant field and obtain insight on what potential study areas could be (3). In recent years, an increasing number of studies using bibliometric analysis in various fields of medicine have been published (4,5).

Interpreting a country's quantitative performance on a particular subject in terms of bibliometric analysis is an important way to evaluate that country's contribution to medical data presentation both qualitatively and quantitatively. The assessment of the research outputs of countries

in clinical neurology as part of a growing research area in the world has previously been conducted in Italy (6), Saudi Arabia (7), and Europe (8). To the best of our knowledge, bibliometric analysis of research output in the field of clinical neurology from Türkiye has not yet been evaluated. Therefore, the objective of this study was to investigate the clinical neurology research output from Türkiye in the last decade using the bibliometric method and network analysis. Our research focused on the citation and co-citation analysis, co-word analysis and clustering analysis of keywords, analysis of the authors, institutions, international collaborations, and cited journals. In this way, this study may guide researchers to see how the clinical neurology research literature from Türkiye has developed over the last decade, to see the current status and trends, and to facilitate for future studies.

METHODS

Source of bibliometric data and search strategies

To carry out this bibliometric analysis, we carried out a search of the Web of Science (WoS) Core Collection database, which is the oldest and most extensively used authorized database for the investigation of scientific and scholarly activity (2). We used the advanced search function to select publications classified in the Clinical Neurology category from the WoS Core Collection database. Articles and review articles were included as document types. Timespan was identified as 2012–2022. Articles published in the journals indexed in Science Citation Index – Expanded (SCI-E) were included. From the scroll-down menu of Countries/Regions, Türkiye was selected. We included articles that had at least one author affiliated with a Turkish institution. Because of the continuous updating of the WoS database, the data scan was completed on March 07, 2023.

Citespace was preferred for the visualization and bibliometric analysis of the data. Citespace allows us to observe the field in depth by presenting not only the investigated publications but also analysis of the citations given in these publications. By analyzing both the content of the publications and the citation network between them, Citespace can provide insight into the structure and dynamics of a particular field or field of research (9). CiteSpace Advances 6.1. R 1 (Drexel University, Philadelphia, Pennsylvania, USA) (update 19.01.2023, software available at <http://cluster.cis.drexel.edu>) was used for the analyses.

In this study, we used three structural criteria to evaluate the structural quality of the network: The modularity Q index, mean silhouette value, and betweenness centrality value. The modularity Q index expresses the degree of divisibility of a network into smaller components. If the modularity Q index is high, lattice clusters have less overlap between clusters (5).

A document co-citation analysis was conducted to examine the links between clinical neurology studies from Türkiye, which is a frequency-based analysis type in which two documents are cited together (3). CiteSpace performs such analyses by examining documents downloaded from scientific databases and references in texts. Co-citation analysis is frequently used in the bibliometric field to examine the evolution of scientific fields, identify influential studies, and track the evolution of research topics over time.

VOSviewer (version 1.6.9) was used for institution networks. To calculate the growth rate of publications and citations by year; we use the formula

$$\text{Growth rate} = \left(\left(\frac{\text{present value}}{\text{past value}} \right)^{1/y} - 1 \right) \times 100$$

y; is the number of years.

RESULTS

General data

As a result of the literature search, 8404 articles in the category of the clinical neurology from Türkiye were found. Figure 1 shows the distribution of the number of publications and citations by year. From 2012 to 2022, the number of publications rose over time. 2021 and 2022 were the highest-yielding years, with 1059 and 1088 papers, respectively. An annual growth rate for publications was approximately 6%. However, the total growth rate from 2012 to 2022 was approximately 85%. When the citations were examined, the annual average growth rate was approximately 59%, and the total growth rate from 2012 to 2022 was approximately 10009%.

Most cited and document co-citation analysis

The number of total citations was 86002, and the mean citation frequency of each article was 10.23. The top 10 most-cited articles are demonstrated in Table 1. The total number of distinct references given in 8404 academic studies was 202268. The top 20 cited references with their centrality are presented in Table 2. The co-citation network of references consisted of 819 nodes and 2673 links. Each node in the map represents cited reference which is one of Citespace's analytic elements. On the average, each node in the network was connected to 24.3 other references. Eleven clusters emerged from the cluster analysis, which provides comprehension of the primary features of scientific mapping. Since the cluster with a silhouette value below 0.5 is considered meaningless, cluster numbers can be skipped. Clusters summary of the references is presented in Table 3. A network map of the cited references with the cluster map and timeline of the co-citation reference analysis were offered in Figure 2. From the timeline, we can see the development of the area, active areas, and clusters. 'Chronic migraine' and 'mental health' clusters were current active areas. It is also seen that 'Multiple sclerosis' was still a partially active cluster. Although Cluster #0 (migraine) and #1 (Covid-19) were the top 2 largest clusters, they were not active. Cluster #4 (temporal lobe epilepsy), to which the top 1 most cited reference (10) belonged, was not active.

A 'burst' term is described as a reference or keyword or author, or institution that emerges with an abrupt change in frequency within the literature during a specific period. Citation burst analyses were carried out to see the most popular years of studies performed by distinct researchers. The top 20 references with the strongest citation bursts are given in Table 4.

Co-word analysis and clustering analysis of keywords

The most popular keywords were children (n=492), prevalence (n=435), management (n=432), multiple sclerosis (n=393), and diagnosis (n=348), respectively. Keyword co-occurrence analysis refers to counting the frequency of keywords appearing in the same literature and analyzing the internal relationships and degree of affinity between keywords. Based on this, closely related keywords are grouped into different clusters through cluster analysis. These clusters reflect the basic research content and basic research areas to which the keywords refer (11). Seven clusters emerged from the cluster analysis. Cluster analysis included cluster #0 (endovascular treatment had 143 keywords), #1 (depression had 127 keywords), #2 (oxidative stress had 97 keywords), #3 (Parkinson's disease had 88 keywords), #4 (epilepsy had 79 keywords), #5 (multiple sclerosis had 66 keywords), #6 (ischemic stroke had 23 keywords). The silhouette value of each cluster from 1 to 6 were 0.544, 0.671, 0.691, 0.646, 0.697, 0.716, and 0.851, respectively. Timeline visualization of keywords according to cluster maps and their interrelationships are shown in the Figure 3. It is seen that all clusters were active. When the keyword bursts were investigated, 'decompression' was described as an active keyword since 2019, and 'Turkish version', and 'fatigue' were active keywords since 2020. These keywords seem to be utilized more commonly in

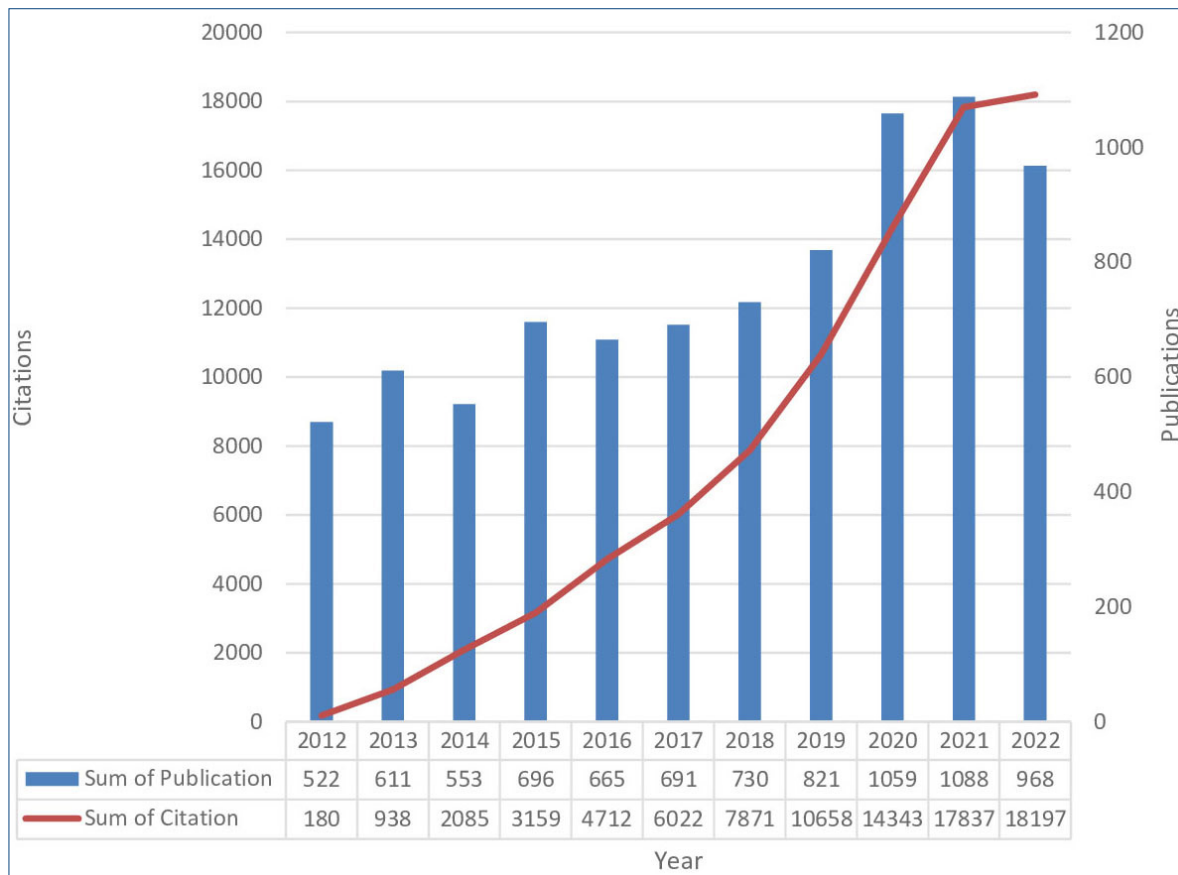


Figure 1. Distribution of the number of publications and citations by year for 8404 articles.

Table 1. Top 10 most cited articles

Ranks	Article	Year	Journal	NC	PY
1	Global, regional, and national burden of neurological disorders, 1990–2016:a systematic analysis for the Global Burden of Disease Study 2016	2019	Lancet Neurology	1801	360.2
2	Diagnostic criteria for mild cognitive impairment in Parkinson's disease: Movement Disorder Society Task Force guidelines	2012	Movement Disorders	1540	128.33
3	Global, regional, and national burden of neurological disorders during 1990–2015:a systematic analysis for the Global Burden of Disease Study 2015	2017	Lancet Neurology	1053	150.43
4	Global, regional, and national burden of Alzheimer's disease and other dementias, 1990–2016:a systematic analysis for the Global Burden of Disease Study 2016	2019	Lancet Neurology	773	154.6
5	International consensus classification of hippocampal sclerosis in temporal lobe epilepsy: A Task Force report from the ILAE Commission on Diagnostic Methods	2013	Epilepsia	581	52.82
6	Global, regional, and national burden of traumatic brain injury and spinal cord injury, 1990–2016:a systematic analysis for the Global Burden of Disease Study 2016	2019	Lancet Neurology	447	44.7
7	International Society of Neuropathology-Haarlem Consensus Guidelines for Nervous System Tumor Classification and Grading	2014	Brain Pathology	404	40.4
8	International Retrospective Study of the Pipeline Embolization Device: A Multicenter Aneurysm Treatment Study	2015	American Journal of Neuroradiology	355	39.44
9	Treatment of Intracranial Aneurysms Using the Pipeline Flow-Diverter Embolization Device: A Single-Center Experience with Long-Term Follow-Up Results	2012	American Journal of Neuroradiology	297	24.75
10	Factors predictive of the development of Levodopa-induced dyskinesia and wearing-off in Parkinson's disease	2013	Movement Disorders	290	26.36

NC: Number of citations; PY: Average citations per year.

Table 2. Top 20 cited references with their centrality value

Counted	Centrality	Year	Cited References
89	0.07	2013	American Psychiatric Association, 2013, DIAGN STAT MAN MENT, V0, P0, DOI 10.1176/appi.books.9780890425596
70	0.09	2013	Bes A, 2013, CEPHALALGIA, V33, P629, DOI 10.1177/0333102413485658
67	0.04	2011	Polman CH, 2011, ANN NEUROL, V69, P292, DOI 10.1002/ana.22366
56	0.00	2016	Louis DN, 2016, ACTA NEUROPATHOL, V131, P803, DOI 10.1007/s00401-016-1545-1
55	0.08	2010	Berg AT, 2010, EPILEPSIA, V51, P676, DOI 10.1111/j.1528-1167.2010.02522.x
51	0.02	2017	Scheffer IE, 2017, EPILEPSIA, V58, P512, DOI 10.1111/epi.13709
51	0.01	2022	American Psychiatric Association, 2022, DIAGN STAT MAN MENT, V5th, P0, DOI 10.1176/appi.books.9780890425787, 10.1176/APPI.BOOKS.9780890425787
41	0.01	2013	American Psychiatric Association, 2013, DIAGN STAT MAN MENT, V5th, P0
39	0.00	2015	Richards S, 2015, GENET MED, V17, P405, DOI 10.1038/gim.2015.30
37	0.00	2020	Mao L, 2020, JAMA NEUROL, V77, P683, DOI 10.1001/jamaneurol.2020.1127
36	0.02	2018	Thompson AJ, 2018, LANCET NEUROL, V17, P162, DOI 10.1016/S1474-4422(17)30470-2
33	0.01	2007	First M., 2007, STRUCTURED CLIN INTE, V0, P0
30	0.02	2018	Olesen J, 2018, CEPHALALGIA, V38, P1, DOI 10.1177/0333102417738202
29	0.06	2014	Fisher RS, 2014, EPILEPSIA, V55, P475, DOI 10.1111/epi.12550
28	0.00	2015	Pellise F, 2015, EUR SPINE J, V24, P3, DOI 10.1007/s00586-014-3542-1
26	0.03	2007	Iber C, 2007, TERMINOLOGY TECHNICA, V1st, P0
26	0.05	2012	Ertas M, 2012, J HEADACHE PAIN, V13, P147, DOI 10.1007/s10194-011-0414-5
26	0.08	2015	Wingerchuk DM, 2015, NEUROLOGY, V85, P177, DOI 10.1212/WNL.0000000000001729
24	0.02	2010	Kwan P, 2010, EPILEPSIA, V51, P1069, DOI 10.1111/j.1528-1167.2009.02397.x
23	0.01	2014	Allen RP, 2014, SLEEP MED, V15, P860, DOI 10.1016/j.sleep.2014.03.025

Table 3. Summary of reference clusters

Cluster ID	Size	Silhouette	Year (mean)
#0 migraine	59	0.960	2015
#1 covid-19	58	0.931	2019
#2 chronic migraine	50	0.962	2009
#3 multiple sclerosis	44	0.96	2016
#4 temporal lobe epilepsy	41	0.974	2012
#6 epilepsy	38	0.989	2015
#7 neuromyelitis optica	37	0.933	2011
#12 restless legs syndrome	19	0.979	2007
#14 mental health	14	0.961	2019
#15 whole exome sequencing	12	0.997	2013
#17 neuromyelitis optica spectrum disease	11	0.964	2016

The size column indicates the size of cluster, the Silhouette column indicates the homogeneity of the cluster.

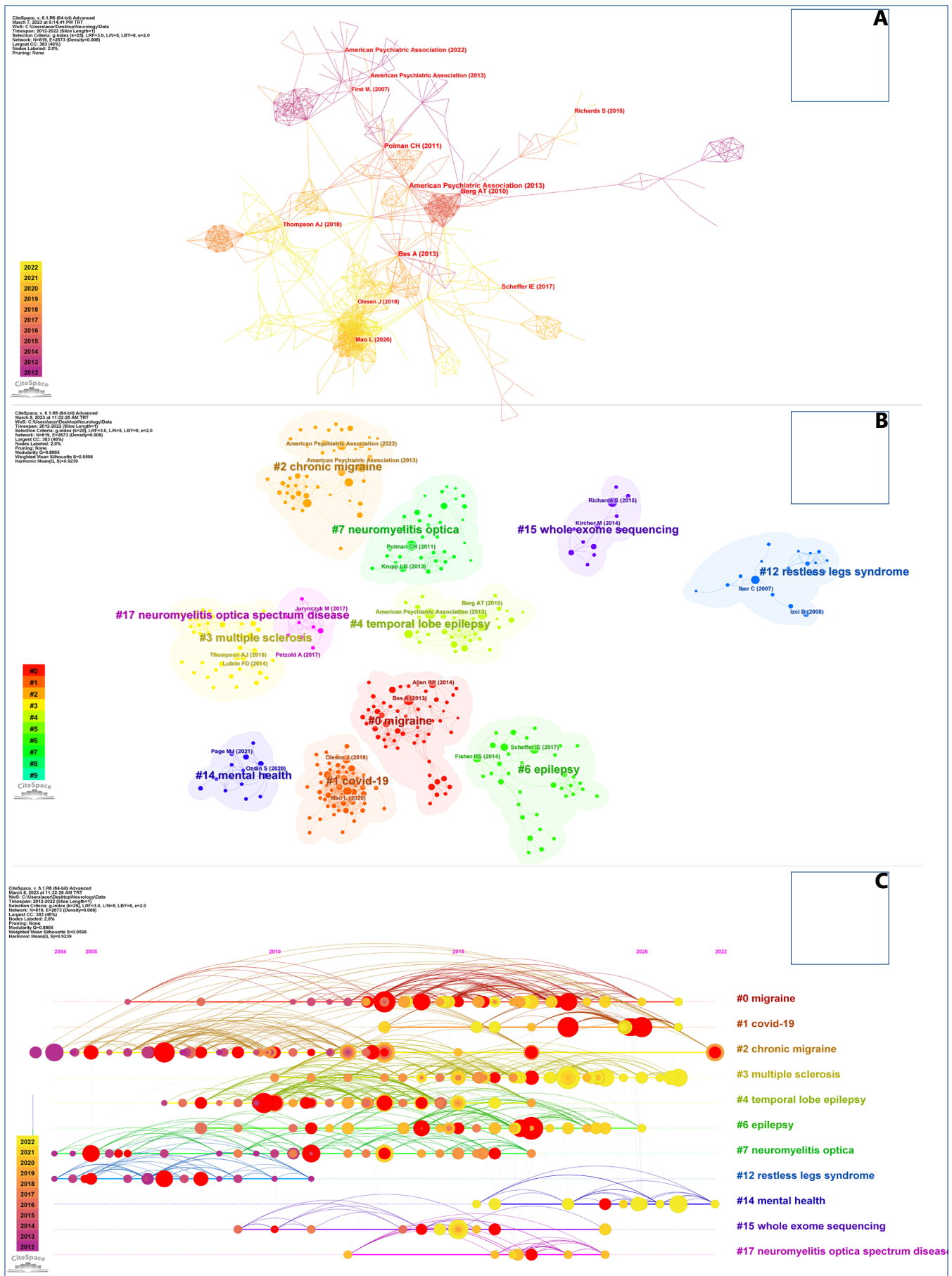


Figure 2. Analysis of references. (A) Cluster map of references. (B) Cluster names represent the topics of the references. (C) The chronological order in which the references appear in each cluster

Table 4. Top 20 references with the strongest citation bursts

References	Year	Strength	Begin	End	2012–2022
Iber C, 2007, TERMINOLOGY TECHNICA, V1st, P0	2007	11.55	2012	2015	
Polman CH, 2005, ANN NEUROL, V58, P840, DOI 10.1002/ana.20703, DOI	2005	8.62	2012	2013	
American Psychiatric Association, 2013, DIAGN STAT MAN MENT, V5th, P0	2013	6.35	2013	2015	
Erel O, 2005, CLIN BIOCHEM, V38, P1103, DOI 10.1016/j.clinbiochem.2005.08.008, DOI	2005	5.74	2012	2013	
Izci B, 2008, SLEEP BREATH, V12, P161, DOI 10.1007/s11325-007-0145-7, DOI	2008	5.3	2012	2015	
First M., 2007, STRUCTURED CLIN INTE, V0, P0	2007	16.36	2013	2015	
Berg AT, 2010, EPILEPSIA, V51, P676, DOI 10.1111/j.1528-1167.2010.02522.x, DOI	2010	10.57	2013	2017	
Polman CH, 2011, ANN NEUROL, V69, P292, DOI 10.1002/ana.22366, DOI	2011	8.77	2015	2019	
American Psychiatric Association, 2013, DIAGN STAT MAN MENT, V0, P0, DOI 10.1176/appi.books.9780890425596, DOI	2013	8.57	2015	2020	
Kwan P, 2010, EPILEPSIA, V51, P1069, DOI 10.1111/j.1528-1167.2009.02397.x, DOI	2010	7.23	2016	2018	
Irani SR, 2010, BRAIN, V133, P2734, DOI 10.1093/brain/awq213, DOI	2010	5.72	2016	2017	
Krupp LB, 2013, MULT SCLER J, V19, P1261, DOI 10.1177/1352458513484547, DOI	2013	5.74	2017	2018	
Bes A, 2013, CEPHALALGIA, V33, P629, DOI 10.1177/0333102413485658, DOI	2013	11.98	2018	2020	
American Psychiatric Association, 2013, DIAGN STAT MAN MENT, V5th, P0, DOI 10.1176/appi.books.9780890425596, 10.1176/APPI.BOOKS.9780890425596, DOI	2013	5.81	2018	2020	
Mao L, 2020, JAMA NEUROL, V77, P683, DOI 10.1001/jamaneurol.2020.1127, DOI	2020	12	2020	2022	
Olesen J, 2018, CEPHALALGIA, V38, P1, DOI 10.1177/0333102417738202, DOI	2018	9.71	2020	2022	
Scheffer IE, 2017, EPILEPSIA, V58, P512, DOI 10.1111/epi.13709, DOI	2017	8.16	2020	2022	
Fisher RS, 2017, EPILEPSIA, V58, P531, DOI 10.1111/epi.13671, DOI	2017	7.1	2020	2022	
Louis DN, 2016, ACTA NEUROPATHOL, V131, P803, DOI 10.1007/s00401-016-1545-1, DOI	2016	6.97	2020	2022	
Guan W, 2020, NEW ENGL J MED, V382, P1708, DOI 10.1056/NEJMoa2002032, DOI	2020	6.13	2020	2022	

The red bars demonstrates the active citation burst time between 2012 and 2022, whereas the thinner blue bar shows the inactive time.

recent years. 'Turkish version' was also found to be the keyword with the strongest citation burst with a strength value of 8.03.

Analysis of the authors

A total of 19116 authors were found in the 8404 articles. Table 5 shows the top 10 most active authors from 2012 to 2022 in this field. The node with a centrality value greater than 0.1 is in the central position. That is, it acts as a key in connecting other nodes. Naci Koçer with a centrality value

of 0.15, Necmettin Tanrıöver with a centrality value of 0.11, Erdem Tuzun with a centrality value of 0.10, and Rana Karabudak with a centrality value of 0.10 were important authors who connected other authors. The authors' co-authorship map and cluster map are shown in Figures 4A and 4B, where each node represents an author. The network had a total of 756 nodes and 2752 links. In total, 129 clusters were generated, with a modularity Q-value of 0.7788, and a mean silhouette-value of 0.9791. It means that the network was divided into homogeneous reliability clusters. The cluster

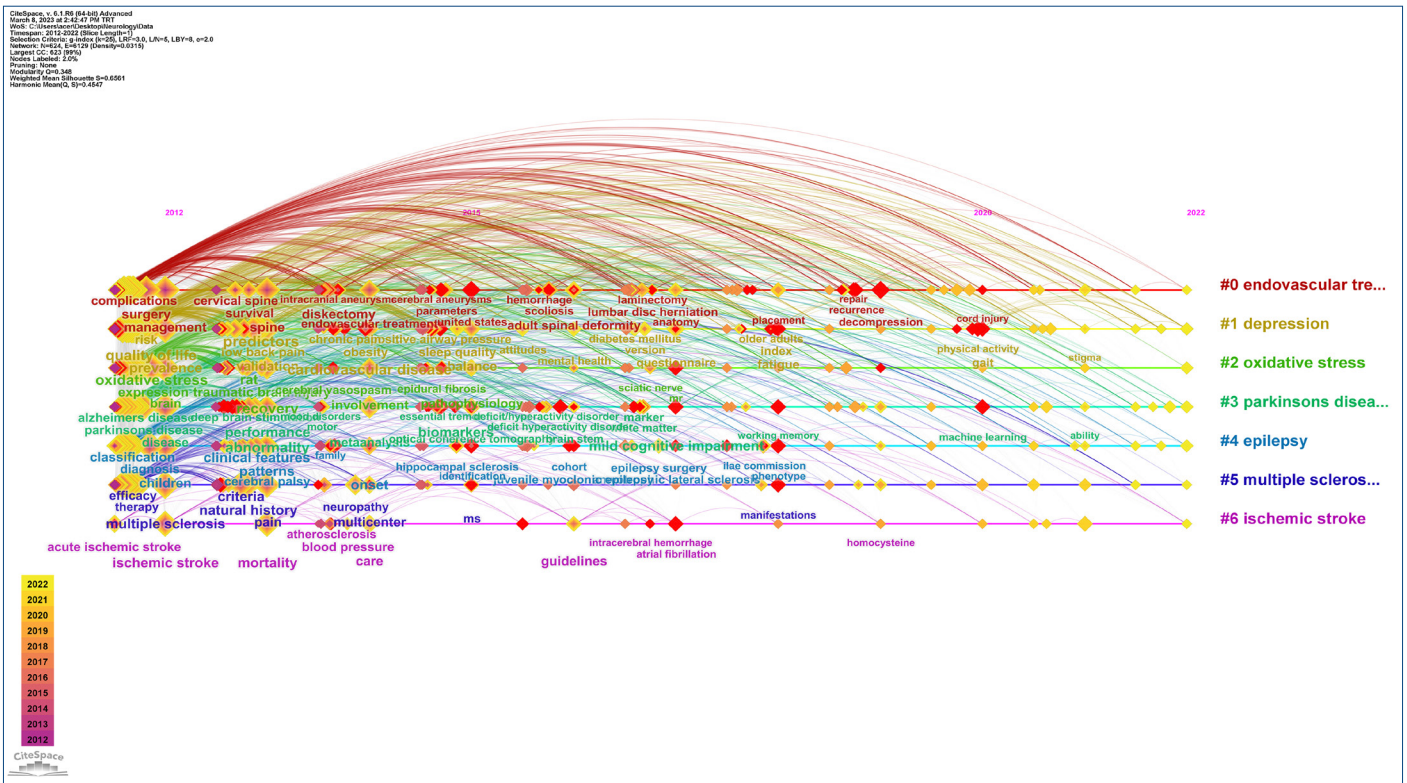


Figure 3. Timeline of cluster analysis map by keywords. The occurrence of keywords in each cluster is in chronological order

Table 5. Top 10 most active authors

Counted	Centrality	Year (mean)	Authors
109	0.01	2012	Baykan, Betul
66	0.02	2012	Boz, Cavit
66	0.10	2013	Tuzun, Erdem
59	0.00	2012	Bebek, Nerses
57	0.06	2014	Siva, Aksel
56	0.08	2012	Gunduz, Aysegul
55	0.00	2015	Alanay, Ahmet
50	0.01	2013	Ozakbas, Serkan
47	0.00	2012	Anlar, Banu
47	0.01	2015	Terzi, Murat

summary is given in Table 6. The cluster name stands for the topics of the authors. Timeline visualization by authors' cluster map was shown in Fig 4C, which presented an overview of the evolution of research areas. The figure demonstrated that the MS cluster seems to be the most active topic in this area and is a recent trend.

Analysis of Institutions and international collaborations

A total of 5786 institutes were found in 8404 publications. The top 5 prolific institutions were Istanbul University with 1144 publications (13.61%), Hacettepe University with 619 publications (7.36%), University of Health Sciences Türkiye with 391 publications (4.65%), Ege University with 339 publications (4.03%), and Dokuz Eylul University with 334 publications (3.97%), respectively.

According to VOSviewer analysis, the authors from Türkiye collaborated with the researchers from 125 different countries in which the US was ranked first with 816 publications (9.43%), followed by Germany with 395 publications (4.70%), Italy with 376 publications (4.47%), England with 359 publications (4.27%), and Spain with 316 publications (3.76%), respectively. The international collaboration map of the publications is demonstrated in Figure 5. There was extensive cooperation between countries.

Analysis of cited journal

The most cited journal on the subject was the Neurology with 2460 citations (2.86%), followed by the Journal of Neurosurgery with 1550 citations (1.80%) and Journal of Neurology, Neurosurgery and Psychiatry with 1508 citations (1.75%).

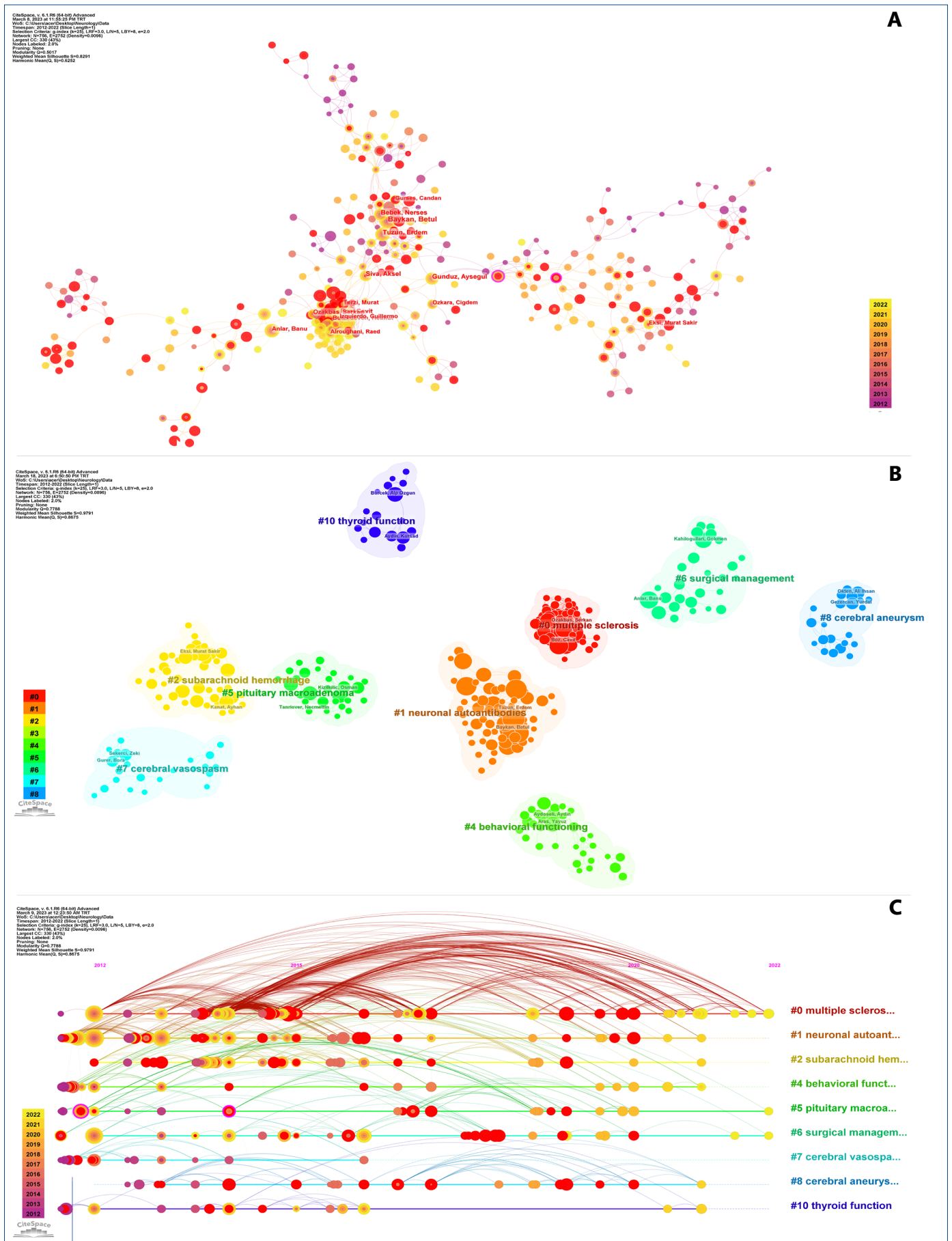
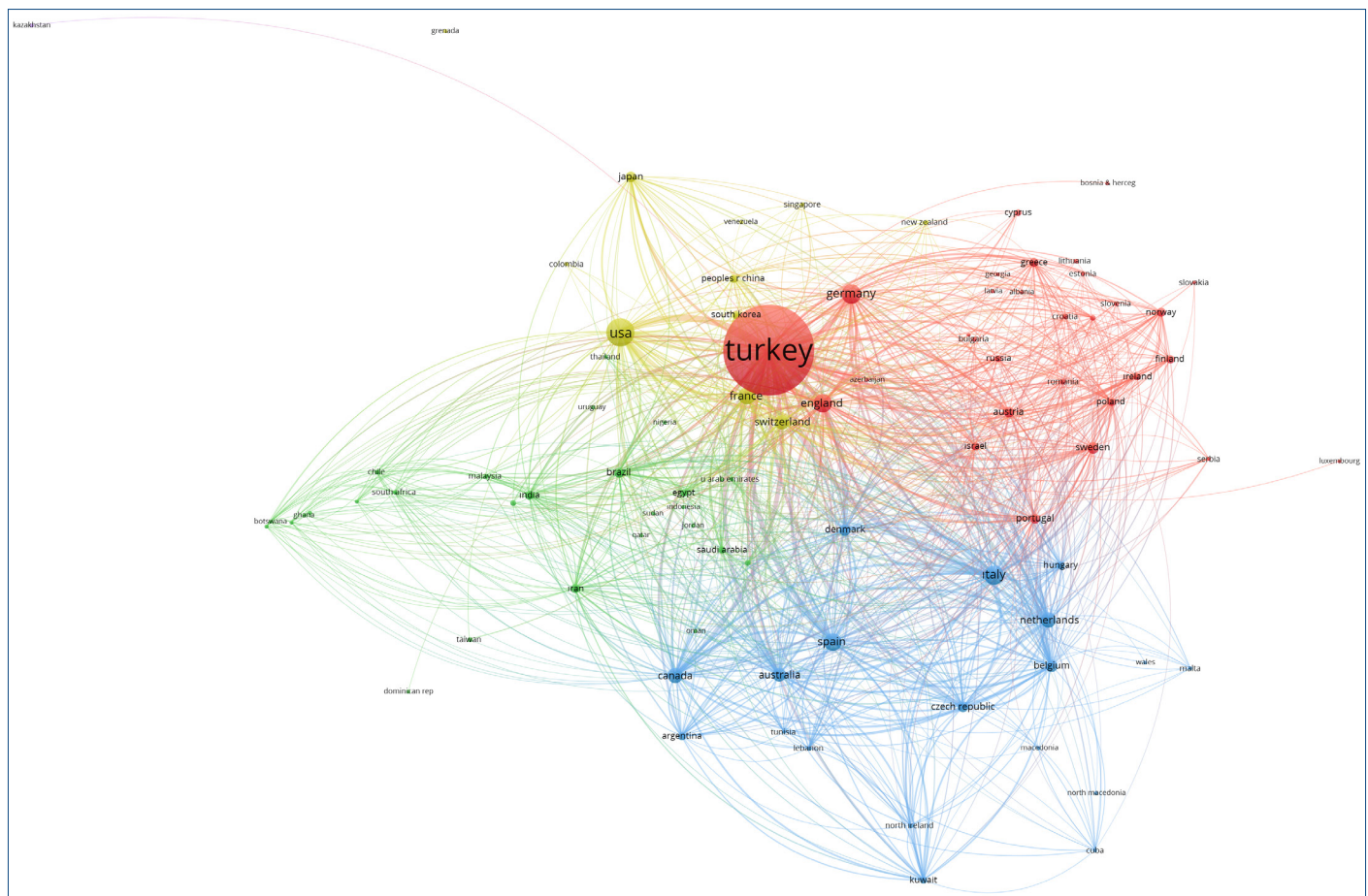


Figure 4. Analysis of the author. (A) The network map of the most active authors (B) The cluster names represent the topics of the authors. (C) Timeline visualization by authors' cluster map

Table 6. Cluster of author summarizes

Cluster ID	Size	Silhouette	Year (mean)	Cluster name
0	74	0.999	2017	multiple sclerosis
1	63	0.959	2015	neuronal autoantibodies
2	44	0.991	2015	subarachnoid hemorrhage
4	32	0.998	2014	behavioral functioning
5	28	0.976	2016	pituitary macroadenoma
6	27	0.95	2017	surgical management
7	23	0.924	2012	cerebral vasospasm
8	22	1.000	2016	cerebral aneurysm
10	17	1.000	2014	thyroid function

The size column indicates the size of cluster, the Silhouette column indicates the homogeneity of the cluster.

**Figure 5.** The international collaboration map of the publications.

DISCUSSION

This study presented the findings of the bibliometric analysis of clinical neurology research outputs from Türkiye. We found 8404 articles in the category of the clinical neurology from the WoS database from 2012 to 2022, in which at least one of the authors was from Türkiye. This is the first study to analyze the status of clinical neurology research in the past decade via CiteSpace and VOSviewer and to display the related research hotspots and current trends.

The number of articles published in the academic scientific literature has been reported to increase at an annual rate of about 3% (12). In our study, the annual growth rate for publications was approximately 6%. From 2012 to 2022, the number of clinical neurology publications increased over time, with a total growth rate of almost 85%, which suggests that research on clinical neurology is attracting more and more attention from the authors from Türkiye and continues to develop. The number of total citations was 86002. Remarkably, the number of citations increased

steadily over the years with a total growth rate of almost 10009%. However, it is worth noting that such a high growth rate is highly unusual. This may be the reason that this field has received the attention of also other fields and may have been cited by other fields.

Among the top 10 cited articles, GBD 2016 Neurology Collaborators had the highest number of citations of 1801 articles published in 2019 in *Lancet Neurology* (1). The study presented the global, regional, and national burden of neurological disorders from 1990 to 2016. The second most cited article, with 1540 citations by Litvan I et al., was published in 2012 in *Movement Disorders* and described diagnostic criteria for mild cognitive impairment in Parkinson's Disease (13). Other most cited articles concerned hippocampal sclerosis classification in temporal lobe epilepsy (14), guidelines for classification and grading of nervous system tumors (15), using the pipeline embolization device (16), and Levodopa-induced dyskinesia and wearing-off in Parkinson's disease (17). These most cited articles play a basic and instructional role in the clinical neurology research area and are worthwhile to study.

Diagnostic and Statistical Manual of Mental Disorders, 5th Edition: DSM-5 by the American Psychiatric Association (10) was the top cited reference in this field. Clinicians and researchers benefit from this exhaustive and crucial resource to describe and categorize the mental disorders, thereby improving the research, diagnoses, and treatment. Moreover, as shown in the Table 4, some references are still cited today. Two of these references are related to coronavirus disease 2019 (18,19) caused by severe acute respiratory syndrome coronavirus 2. After the World Health Organization (WHO) declared COVID-19 as a pandemic on March 11, 2020, neurological manifestations of COVID-19 have been documented in an increasing number of publications (18,19). Therefore, it is not surprising that these two articles have been cited since 2020. Other recently cited articles are related to the international classification of headache disorders (20), the International League Against Epilepsy classification of the epilepsies (21) and seizure types (22), WHO classification of central nervous system tumors (23). These articles are leading resources in this field.

According to the results of the reference cocitation analysis, most recent publications were on the theme of chronic migraine and mental health. Chronic migraine patients have a higher incidence of medical and mental health disorders such as depression and anxiety (24). It can be expected that the publications in these areas will increase.

As an overview of the literature theme, the keywords are highly refined and generalized to a specific topic, and can fully interpret the literature. Using high-frequency keywords to highlight research points in a discipline can effectively identify research points and other key issues (5). The findings of the co-word analysis and clustering analysis of keywords indicated that active research hotspots were endovascular treatment, depression, oxidative stress, Parkinson's disease, epilepsy, multiple sclerosis (MS), and ischemic stroke. Also, the cluster of endovascular treatment was the biggest.

Betul Baykan, Cavit Boz, and Erdem Tuzun were at the forefront with regard to the number of publications, demonstrating the remarkable contributions that these 3 authors made to the field of clinical neurology. Moreover, according to centrality value, Naci Kocer, Necmettin Tanriöver, Erdem Tuzun, and Rana Karabudak were striking, suggesting that the scholarship of these authors is important to this field. Although Necmettin Tanriöver, Naci Koçer, and Ahmet Alanay are not neurologists, they are among the top contributors to this field. It is not uncommon for a paper in the field of clinical neurology to include authors who are neurosurgeons, spine surgeons, or neuroradiologists, as neurosurgery,

neuroradiology, and clinical neurology are closely related and often overlap in terms of diagnosis and treatment of neurological conditions. Betul Baykan and Erdem Tuzun were from Istanbul University, which was the top one institution according to publication records; it may be said that this institution was the key source and pioneer in the improvement of the clinical neurology area. These authors belonged to the cluster 'neuronal autoantibodies' (Figure 4). They have made great contributions to the development of this field (25). Cavit Boz belonged to cluster #0 (MS), which had the largest size. The author has conducted studies, particularly on MS (26). From the timeline visualization by the authors' cluster map (Figure 4C), cluster #0 (MS) was still active. Our results strikingly showed that MS is seen as the most preferred research field by the authors from Türkiye and the main current research trend in the field of clinical neurology. Additionally, fatigue was one of the top 20 keywords with the highest citation burst and has been an active keyword since 2020. Fatigue has been reported to be among the most common symptom of MS patients (27).

International collaborations can make possible novel advances in diagnostical and management approaches. Our findings indicated that authors from Türkiye collaborated with researchers from many different countries in the clinical neurology field. The US, which is the world leader in terms of the number of medical research publications owing to its great number of researchers and technological and financial support (6), ranked first, followed by many European countries (Figure 5). It is worth noting that most of the international collaborations were from developed countries which may be useful in developing the clinical neurology academic studies from Türkiye.

Examining the most cited journal, since 2012, *Neurology* [Impact Factor (IF): 12.2], *Journal of Neurosurgery* (IF: 5.4), and *Journal of Neurology, Neurosurgery and Psychiatry* (IF: 13.6) were the top 3, which might be expected from the IF of these journals. Although the *Journal of Neurosurgery* is the journal of the field of neurosurgery, it is also listed under the clinical neurology category.

This study should be assessed within the limitations. Firstly, we examined only papers published in scientific journals classified in the subject category of clinical neurology. Clinical neurology articles published in journals classified in other categories, such as Neuroscience, Neuroimaging, or General and Internal Medicine, were not included in this study unless the journal was designed for both categories simultaneously. Secondly, the articles indexed only in WoS and SCI-E databases were included. Exclusion of other databases may have influenced our findings to a small extent. We used WoS because it is most broadly available, has a large collection and exhaustive citation tracking, and articles published index in more valid journals than databases such as Google Scholar, PubMed, and Scopus (3). Thirdly, only two types of literature (the original articles and the reviews) were included. Despite the fact that these two literature types could fundamentally represent the outputs in this field, a small portion of the information may still be lost.

As a result; neurological disorders are one of the most prevalent disorders, with a great burden on the affected persons, their relatives, and the community. Clinical neurology is a rapidly expanding research field, attracting more and more attention from the authors, and is open to expansion, which is an important effect on public health and quality of life. Bibliometric analysis was used by analyzing large data in which hot spots, citations, and collaborations relationships were evaluated. Our study can help researchers for their further studies in terms of which areas of clinical neurology research from Türkiye are clustered more and which areas they can focus on.

Ethics Committee Approval: This study performed bibliometric analysis of existing published studies and did not involve human or animal subjects, therefore, it does not require ethical approval.

Informed Consent: This study performed bibliometric analysis of existing published studies and did not involve human or animal subjects, therefore, it does not require informed consent.

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