

Neurological Impacts of Covid-19 and Worldwide Scientific Production about the Subject: A Bibliometric Analysis

Impactos Neurológicos da Covid-19 e Produção Científica Mundial sobre a Temática: Uma Análise Bibliométrica

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ABSTRACT

Introduction: The novel Coronavirus (COVID-19) was first reported by officials in Wuhan City, in December 2019. It has rapidly spread with confirmed cases in almost every country across the world and has caused a global public health crisis.¹ The epidemiological update of the World Health Organization on 9th March 2021 showed that over 2.7 million new cases were reported. In this article, a bibliometric analysis of trending topics and what is being researched regarding COVID-19 and its neurological involvement is done.

Methods: This research was conducted on the Web of Science Core Collection (WoS). For research in WoS, keywords in English were used, according to DeCS - Descriptors in Health Sciences. The search strategy with Boolean operators was: TS = (SARS-CoV-2 OR COVID-19) AND TS=(Neurologic Findings OR Neurology OR Neurologic Manifestations).

Results: In total, 392 scientific productions were identified and included in this bibliometric analysis. The studies were published in the period between March 2020 and March 2021, with records prevalent in the themes of clinical neurology (n=234) and neurosciences (n=134), as well as several other areas. The thirty studies collected a total of 3395 citations, with variations from 1433 to 26 and average of 113 citations per study. All were published in 2020, with bigger prevalence in July (nine articles) and June (six articles).

Conclusion: It is expected that this bibliometric survey will serve as a manner of presenting the main topics of study within neurology before COVID-19, in addition providing guidance for future research.

Keywords: SARS-CoV-2. COVID-19. Neurologic Findings. Neurology. Neurologic Manifestations.

RESUMO

Introdução: O novo Coronavírus (COVID-19) foi relatado pela primeira vez por autoridades na cidade de Wuhan, em dezembro de 2019. Ele se espalhou rapidamente com casos confirmados em quase todos os países do mundo e causou uma crise global de saúde pública. A atualização epidemiológica da Organização Mundial da Saúde em 9 de março de 2021 mostrou que mais de 2,7 milhões de novos casos foram relatados. Neste artigo, é feita uma análise bibliométrica dos trending topics e do que está sendo pesquisado sobre o COVID-19 e seu envolvimento neurológico.

Métodos: Esta pesquisa foi realizada na Web of Science Core Collection (WoS). Para a pesquisa na WoS, foram utilizadas palavras-chave em inglês, conforme DeCS - Descritores em Ciências da Saúde. A estratégia de busca com operadores booleanos foi: TS = (SARS-CoV-2 OR COVID-19) AND TS=(Neurologic Findings OR Neurology OR Neurologic Manifestations).

Resultados: No total, 392 produções científicas foram identificadas e incluídas nesta análise bibliométrica. Os estudos foram publicados no período entre março de 2020 e março de 2021, com registros prevalentes nos temas de neurologia clínica (n=234) e neurociências (n=134), além de diversas outras áreas. Os trinta estudos coletaram um total de 3.395 citações, com variações de 1.433 a 26 e média de 113 citações por estudo. Todos foram publicados em 2020, com maior prevalência em julho (nove artigos) e junho (seis artigos).

Conclusão: Espera-se que este levantamento bibliométrico sirva como forma de apresentar os principais tópicos de estudo dentro da neurologia antes da COVID-19, além de fornecer orientações para pesquisas futuras.

Palavras-chave: SARS-CoV-2. COVID-19. Achados Neurológicos. Neurologia. Manifestação Neurológica.

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INTRODUCTION

The novel Coronavirus (COVID-19) was first reported by officials in Wuhan City, in December 2019. It has rapidly widespread with confirmed cases in almost every country across the world and has become a global public health crisis¹. Weekly epidemiological update of the World Health Organization on 9th March 2021 showed that over 2.7 million new cases were reported².

The designation of the etiological agent is Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Human transmission may occur through contact with respiratory secretions of infected people. The World Health Organization declared this novel coronavirus disease a pandemic on March 11, 2020¹.

Although the main clinical manifestations are from the respiratory tract, neurological disorders related to COVID-19 have been reported increasingly in literature, ranging from non-specific viral symptoms (such as headache and myalgia) to severe damage to the central and peripheral nervous system, as well as cerebrovascular diseases, which demonstrates the neuroinvasive potential of SARS-CoV-2³. As disease cases increase, the number of reports of neurological complications rise, which can be directly related to the systemic or immune-mediated effects of the virus⁴.

The alarming growth of the disease evidenced the importance of investments in scientific research productions on Covid-19. To provide better guidance to the health coordination sector, knowledge on the subject has to be aligned with measures to combat the infection⁵. One of the best ways to do this is through bibliometric analysis, whose principle it is to analyze the scientific or technical activity through quantitative studies of publications⁶.

In this perspective, knowledge on the world scientific production about COVID-19 and its neurological reflexes is necessary to guide future research, as well as to summarize and disseminate the productions. Therefore, we sought to develop a bibliometric analysis and answer the research question: What is being researched and what are the trending topics regarding COVID-19 and its neurological involvement?

METHODS

Search strategy

This research was conducted on the Web of Science Core Collection (WoS) to survey the scientific production relevant to the topic. There was no cut by publication time of articles or languages. Searches were conducted online on March 11, 2021 with inclusion of all results, no exclusion criteria were used for greater data coverage.

For research in WoS, keywords in English were used, according to DeCS - Descriptors in Health Sciences. The search strategy with Boolean operators was: TS = (SARS-CoV-2 OR COVID-19) AND TS = (Neurologic Findings

OR Neurology OR Neurologic Manifestations). Advanced search in the Topic (TS) field includes searching for terms in the following record fields: title, abstract, author keywords, and Keywords Plus®.

Data extraction and analysis

Data collection and analysis were performed using the RStudio® Software (version 1.4.1103), with the appliance of the Bibliometrix and Biblioshiny packages. The graphic productions generated from this software were: Figure 1. Journals with respective number of publications related to COVID-19 and neurological impact, Figure 2. World Cloud with the most frequent keywords of the authors and Figure 3. Country collaboration map for publications related to COVID-19 and neurological impact.

The parameters applied in Graph 1 were the Top 15 of the most relevant sources from the quantity of scientific productions published until March 11th. For the word cloud, the field "Author's keywords" was analyzed by measuring the frequency of the 50 most registered words.

The other elements analyzed in this article were: Top 30 most cited studies, with name of the first author, month and countries of study; Classification of study types; Top 15 authors affiliations or institutions with number of studies published.

RESULTS

In total, 392 scientific productions were identified and included in this bibliometric analysis. The studies were published in the period March 2020 and March 2021, with records prevalent in the themes of clinical neurology (n=234) and neurosciences (n=134), as well as several other areas.

Table 1 lists, in descending order, the 30 most cited studies, with their respective titles, main author, country of affiliation, month and year of publication, and number of citations. The thirty studies collected a total of 3395 citations, with variations from 1433 to 26 and average of 113 citations per study. All were published in 2020, with bigger prevalence in July (nine articles) and June (six articles). Regarding the first author's country of affiliation, three deserve mention: United States of America (USA), with fifteen affiliations, United Kingdom (UK), seven, and Spain, four. The most cited study was "Neurologic Manifestations of Hospitalized Patients With Coronavirus Disease 2019 in Wuhan, China" with 1433 citations, published in June 2020, authored by Mao, Ling, China being his country of affiliation.

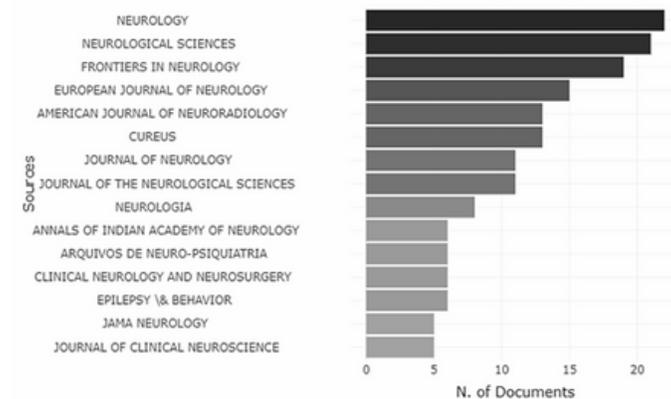
Table 1. Top 30 most cited studies, with name of the first author, month and authors affiliation countries. Date accessed: March 2021.

Publication Title	First authors	Month (Year)	Authors affiliation countries	Quotations no
Neurologic Manifestations of Hospitalized Patients With Coronavirus Disease 2019 in Wuhan, China	Mao, Ling et al. ⁴	JUN (2020)	China	1433
Central nervous system manifestations of COVID-19: A systematic review	Asadi-Pooya, Ali A. et al. ⁷	JUN (2020)	USA; Iran	197
Extrapulmonary manifestations of COVID-19	Gupta, Aakriti et al. ⁸	JUL (2020)	USA	192
Miller Fisher syndrome and polyneuritis cranialis in COVID-19	Gutierrez-Ortiz, Consuelo et al. ⁹	AUG (2020)	Spain	175
Neuropathogenesis and Neurologic Manifestations of the Coronaviruses in the Age of Coronavirus Disease 2019 A Review	Zubair, Adeel S. et al. ¹⁰	AUG (2020)	USA	110
Hypertension, Thrombosis, Kidney Failure, and Diabetes: Is COVID-19 an Endothelial Disease? A Comprehensive Evaluation of Clinical and Basic Evidence	Sardu, Celestino et al. ¹¹	MAY (2020)	Italy; USA	109
The emerging spectrum of COVID-19 neurology: clinical, radiological and laboratory findings	Paterson, Ross W. et al. ¹²	OCT (2020)	UK	108
Neurological and neuropsychiatric complications of COVID-19 in 153 patients: a UK-wide surveillance study	Varatharaj, Aravinthan et al. ¹³	OCT (2020)	UK	105
Neurologic manifestations in hospitalized patients with COVID-19 The ALBACOVID registry	Romero-Sanchez, Carlos Manuel et al. ¹⁴	AUG (2020)	Spain	95
Neurological manifestations of COVID-19 and other coronavirus infections: A systematic review	Montalvan, V. et al. ¹⁵	JUL (2020)	USA	90
Brain MRI Findings in Severe COVID 19: A Retrospective Observational Study	Kremer, Stephane et al. ¹⁶	NOV (2020)	France	61
Neurological manifestations and complications of COVID-19: A literature review	Ahmad, Imran et al. ¹⁷	JUL (2020)	Pakistan	61
Frequent Convulsive Seizures in an Adult Patient with COVID-19: A Case Report	Karimi, Narges et al. ¹⁸	MAR (2020)	Iran	58
The Neurology of COVID-19 revisited: A proposal from the Environmental Neurology Specialty Group of the World Federation of Neurology to implement international neurological register	Roman, Gustavo C. et al. ¹⁹	JUL (2020)	UK; USA; France; Morocco; India; Spain; Honduras; Japan; Turkey; Pakistan	57
COVID-19: A Global Threat to the Nervous System	Koralnik, Igor J. et al. ²⁰	JUL (2020)	USA	54
Neurological Manifestations of COVID-19: A systematic review and current update	Whittaker, Abigail et al. ²¹	JUL (2020)	UK	49
Guillain-Barre syndrome: The first documented COVID-19-triggered autoimmune neurologic disease: More to come with myositis in the offspring	Dalakas, Marinos C. ²²	SEP (2020)	USA; Greece	39
Neurologic manifestations in an infant with COVID-19	Dugue, Rachelle et al. ²³	JUN (2020)	USA	39
Neurobiology of COVID-19	Fotuhi, Majid et al. ²⁴	2020	USA	39
Mechanical Thrombectomy in the Era of the COVID-19 Pandemic: Emergency Preparedness for Neuroscience Teams A Guidance Statement From the Society of Vascular and Interventional Neurology	Nguyen, Thanh N. et al. ²⁵	JUN (2020)	USA	34
Emergency room neurology in times of COVID-19: malignant ischaemic stroke and SARS-CoV-2 infection	Gonzalez-Pinto, T. et al. ²⁶	SEP (2020)	Spain	33

Cerebrovascular Disease in COVID-19	Goldberg, Michael F. et al. ²⁷	JUL (2020)	USA	32
COVID-19, SARS and MERS: A neurological perspective	Kwong, Koy Chong Ng Kee et al. ²⁸	JUL (2020)	UK; Canada	32
Neurologic and Radiographic Findings Associated With COVID-19 Infection in Children	Abdel-Mannan, Omar et al. ²⁹	NOV (2020)	UK	31
Neurosurgery and Neurology Practices during the Novel COVID-19 Pandemic: A Consensus Statement from India	Gupta, Prakamya et al. ³⁰	MAR-APR (2020)	India	29
Rapid implementation of virtual neurology in response to the COVID-19 pandemic	Grossman, Scott N. et al. ³¹	JUN (2020)	USA	28
Lessons of the month 1: A case of rhombencephalitis as a rare complication of acute COVID-19 infection	Wong, Po Fang et al. ³²	MAY (2020)	UK	27
Brain Imaging Use and Findings in COVID-19: A Single Academic Center Experience in the Epicenter of Disease in the United States	Radmanesh, A. et al. ³³	JUL (2020)	USA	26
Neurological manifestations of the coronavirus (SARS-CoV-2) pandemic 2019-2020	Liu, Kaiping et al. ³⁴	JUN (2020)	China	26
Preparing a neurology department for SARS-CoV-2 (COVID-19): Early experiences at Columbia University Irving Medical Center and the New York Presbyterian Hospital in New York City	Waldman, Genna et al. ³⁵	MAY (2020)	USA	26

Source: the authors, 2021.

The fifteen most relevant sources of the analyzed scientific productions (Graphic 1) add up to a total of 167 published documents, representing 42.6% of the grand total included. Neurology being the most relevant source with 22 records, followed by Neurological Sciences, with 21, Frontiers in neurology, 19, European Journal of Neurology, 15, and American Journal of Neuroradiology, and Cureus, with 13.



Graphic 1. Journals with respective number of publications related to COVID-19 and neurological impact.

Source: the authors, 2021.

Table 2 presents the classification of the studies in 7 categories: 1) Article; 2) Review; 3) Editorial material; 4) Early Access; 5) Letter; 6) Correction and 7) meeting abstract. With approximately 56% of the total, articles were the most published type of study (220), followed by secondary productions such as bibliographic reviews (24%-95 publications), editorials (11% - 44 publications), Early access (9% - 37 publications), Letter (7.6% - 30

publications) and corrections and Meeting abstracts with, respectively, 2 and 1 publishing.

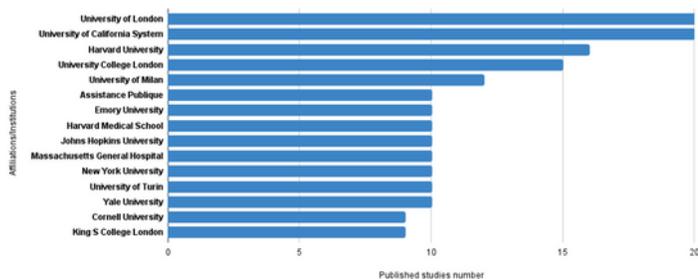
Table 2. Classification of study types and number of articles published.

Type of documents	Articles Published N	% of 392
Article	220	56.12
Review	95	24.26
Editorial material	44	11.22
Early access	37	9.44
Letter	30	7.65
Correction	2	0.51
Meeting abstract	1	0.26

Source: the authors, 2021.

The authors' Top 15 affiliations/link institutions (Graphic 2) show the highlight of studies carried out by the University of London, with 22 scientific productions on COVID-19 and its neurological manifestations. The institutions of the United States of America were the most productive in the subject (105 studies), making the country the biggest world research center on the disease, with emphasis on the University of California System (n=20), Harvard University (n=16), Emory University (n=10), Harvard Medical School (n=10), Johns Hopkins University (n=10), Massachusetts General Hospital (n=10), New York University (n=10), Yale University (n=10) and Cornell University (n=9).

Affiliations/Institutions and Published studies number



Graphic 2. Top 15 authors affiliations or institutions with number of studies published.

Source: the authors, 2021.

Figure 1 shows a cloud of keywords most frequently used by authors, demonstrating that the more recurrent, the greater the word length. The most discussed topics were coronavirus, present in 208 studies, associated with neurological manifestations such as stroke, encephalitis, Guillain-Barré syndrome, epilepsy, headache, inflammation and delirium. The association of the neurological study with telemedicine occurred in a relevant

way, as observed in the terms telemedicine, telehealth and telemedicine highlighted. In addition, words such as mortality, pandemic, anosmia and neuroinflammation are also highlighted.



Figure 1. World Cloud with the most frequent keywords of the authors.

Figure 2 represents a map of collaboration between countries, in which the red lines symbolize this exchange. There is an intense collaboration between European countries, with emphasis on Italy and the United Kingdom (13 studies), Italy and France (12 studies), United Kingdom and France (12 studies). In addition, the United States of America makes contributions with countries from several continents, such as France (10 studies), Canada (9 studies), China (8 studies) and India (7 studies).



Figure 2. Country collaboration map for publications related to COVID-19 and neurological impact.

DISCUSSION

An increased production about Covid-19 and its relationship with neurological disorders is observed within the scientific community with a strong social collaboration in the context of the pandemic. When analyzing Table 1, it is prominent that the top 30 articles were all published in 2020. Since the new virus emerged at the end of 2019, there was no relevance for scientific production until then.

The highest observed frequency of publications was in the months of June and July, likely because it was the period after the first major peak of the pandemic. The global wave of contamination lessened for a few days and again jumped to a higher peak. This period was inviting for scientific production because of the extreme need to find

not only treatment but also prevention of infection.

Furthermore, the most cited article from Table 1 was published in Wuhan, China, likely because it was the cradle of the first contaminations. The exponential growth in COVID-19 cases results from its high capacity for infection, the lack of previous immunity of the populations and the lack of vaccination or treatment for the virus³⁶.

Rapid neuroinvasion of COVID-19 generates symptoms relating to the central nervous system such as dizziness, headache, impaired consciousness, acute cerebrovascular disease, ataxia and convulsions, manifestations of the peripheral nervous system such as impairment of taste, impairment of smell, impairment of vision and nervous pain and manifestations of skeletal muscle injury. In patients with COVID-19 that present neurological manifestations, physicians should suspect SARS-CoV-2 infection as a differential diagnosis to avoid late diagnosis or misdiagnosis and lose the chance to treat and prevent neurological sequelae and even avoid further transmission, according to Mao, Ling et al^{4,37}.

According to the publications listed in Table 1, the highest symptomatic incidences were myalgia, headache, anosmia, encephalitis, encephalopathies, epileptic seizures, Guillan Barre syndrome. SARS-Cov-2 has been shown to be neuroinvasive and penetrates the central nervous system through the medulla, olfactory and the infection extends through extraneuronal pathways and other regions of the brain³⁸.

According to graph 2, the countries with most publications are the United States of America and the United Kingdom, with 105 and 31 publications on COVID-19 and its neurological manifestations, respectively. These two countries have esteemed research institutes that do research on clinical observation of patients and their post-infectious effects.

Figure 2 shows the geographical links between scientific publications, which highlights the United States and Europe as the main vectors for the propagation and production of relevant information regarding COVID-19 and its neurological impact. These countries have a strong economy with high public spending on scientific production related to these research topics.

There were 392 observed publications in the bibliometric analysis for this study. The medical scientific society, through various scientific productions, has had a fundamental role in improving the well-being of patients after a COVID-19 infection. In the case of this article the focus is on the neurological effects, but there are many other long-term effects to be investigated that will need scientific support to provide reliable information for good management of these patients.

CONCLUSION

This bibliometric analysis presented a detailed survey of worldwide publications on the relationship

between SARS-CoV-2 and its neurological effects. Thus, it is expected that this bibliometric survey will serve as a manner of presenting the main topics of study within neurology before COVID-19, in addition providing guidance for future research.

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