



ISSN 2545-2533

Received: 08.05.2021

Accepted: 25.05.2021

Published: 30.06.2021

Distribution of papers on COVID-19 in the field of anesthesiology in individual countries and journals.

Pinar Ayvat ¹ - A,B,C,E,F,H,I,L,M,O.  ORCID www.orcid.org/0000-0002-9941-3109

¹ Izmir Democracy University, School of Medicine, Anesthesiology and Reanimation Department, Karabaglar, Izmir, Turkey.

Address for correspondence:

Pinar Ayvat, MD - Izmir Democracy University, School of Medicine, Anesthesiology and Reanimation Department, Uckuyular Mahallesi, Gursel Aksel Bulvarı, No:14, 35140 Karabaglar, Izmir, Turkey;
E-mail: drpinarunde@yahoo.com

Author Contributions (CRediT Taxonomy):

Conceptualization - A
Data Curation - B
Formal Analysis - C
Funding Acquisition - D
Investigation - E
Methodology - F
Project Administration - G
Resources - H
Software - I
Supervision - J
Validation - K
Visualization - L
Writing (Draft Preparation) - M
Writing (Review & Editing) - N
Approved the final version - O

ABSTRACT

INTRODUCTION: There are many published papers on COVID-19 in the field of anesthesia recently. However, there isn't any study that indicates what kind of issues countries and journals are focusing on this particular subject. The aim of this paper is to determine the countries and journals that contribute the most to the literature on COVID-19 in the field of anesthesia and also to examine the features that make the difference in the total cited count numbers of related papers.

MATERIAL AND METHODS: The search engine of the Web of Science was used for the selection of papers. The search yielded 359 published materials in total. However, 78 (61 Articles, 17 Reviews) of them did not have keywords. Therefore, they were excluded from the analysis. The remaining 196 articles plus 84 reviews, in total 280 papers were examined. In order to examine the differences between published materials in terms of total cited count numbers, independent samples t-tests and one-way Anova test were performed with SPSS. In order to explore the topical differences, the keywords according to country of the first author, and the journal were mapped. KNIME and FactoMiner software were used for the analysis.

RESULTS: Results indicated that international papers were cited more compared to domestic papers; multi-centered national papers were cited more compared to single-centered national papers. The largest percentage (34.64%) of the overall publications originated from Anglo-American countries (USA=13.93%; England=12.14%; Canada=6.07%; Australia=2.50%). The keyword mapping showed that COVID-19, Sars-cov-2, Pandemic, Anesthesia, Airway, Acute Respiratory Distress Syndrome, Critical Care, Intensive Care, Personal Protective Equipment, Infection, Mortality, and Mechanical Ventilation were the main keywords of these published materials.

CONCLUSIONS: This paper not only showed the features of papers that are cited more but also showed the ranking of countries that contribute the most to the literature and reflected the hot topics about COVID-19 in the field of anesthesia. Extensive studies about COVID-19 have already begun, and the number of studies keep increasing. Therefore, this study could provide hints for authors who would like their papers to be cited more as well as useful information for further research.

KEY WORDS: COVID-19, anesthesia, citation impact, international co-authorship, bibliometric analysis.

INTRODUCTION

The coronavirus outbreak (Coronavirus Disease 2019: COVID-19) first started in December 2019 in the form of "unexplained pneumonia" in Hubei province, in Wuhan region of China. The World Health Organization, due to its similarity to SARS CoV, named the new virus that caused the disease as SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2). The virus, which spread to all countries and continents in a short period, showed its drastic effects all over the world. The number of cases and incidences in countries varied depending on the demographic structure of the population, population density, number of tests, filtration implementing, and disease control measures.

COVID-19 spread rapidly and affected the whole world, causing lockdowns in many countries and bringing business life to a halt, but the health sector continued to serve with an unceasing effort and even heavier workload. Scientists from many disciplines continued to focus on this subject and published their works in academic journals. Anesthetists, who are at the front lines of the fight against COVID-19, are undoubtedly one of the valuable groups of scholars contributing to the literature.

The main goal of this study is to examine the features that make the difference in the total cited count numbers of publications on COVID-19 in the field of anesthesia. In addition, a country-wise and a journal-wise analysis are also performed to determine the countries and journals that contribute the most to the literature on COVID-19 in the field of anesthesia. The research questions (RQ) are:

RQ1: In terms of total cited count numbers, are there differences between published materials on COVID-19 in the field of anesthesia?

RQ2: What are the country-wise and journal-wise distribution of scientific publications on COVID-19 in the field of anesthesia?

RQ3: What are the main keywords of current scientific publications and how are these keywords grouped and mapped in terms of the countries and the journals on COVID-19 in the field of anesthesia?

MATERIAL AND METHODS

The search engine of the Web of Science (WoS) database was used for the selection of the publications. The search string "**WC=(Anesthesia OR Anesthesiology OR Anaesthesia OR Anaesthesiology) AND TI=(COVID-19)**" was written in the "Advanced Search" section of WoS. WC included all the published materials in the Web of Science Category of anesthesia and TI included all the published materials that have the word COVID-19 in their titles. Figure 1 shows the methodology for the selections of published materials. The search was done on 11th May 2021. The result included eight different document types: Article, correction, editorial material, letter, meeting abstract, news item, retraction, and review. Corrections, editorial materials, letters, meeting abstracts, retractions, and news items were eliminated. The search yielded 359 published materials on COVID-19 in the field of anesthesia.

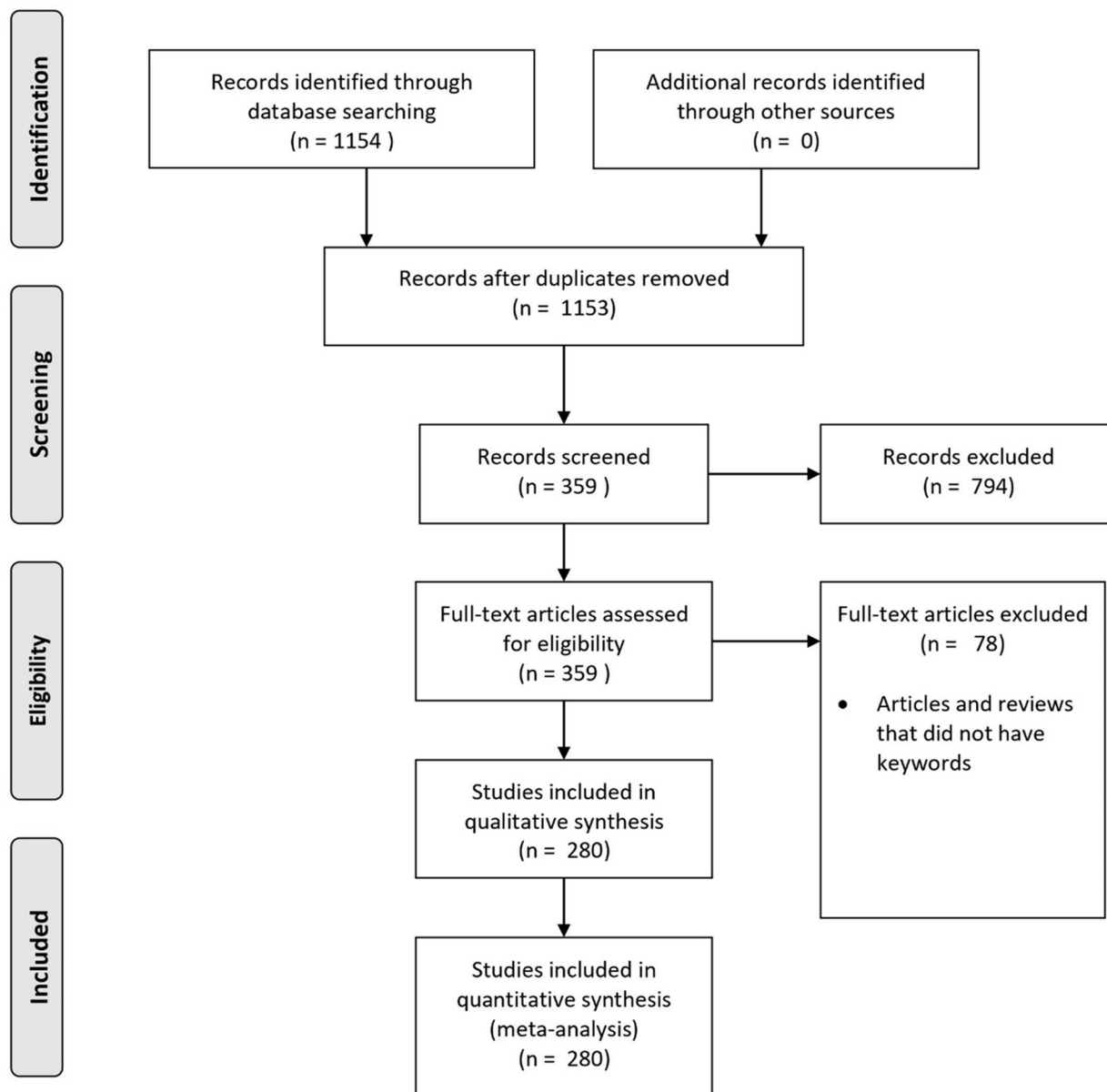


Figure 1. Methodology for the selection of published materials.

Sixty-one articles and seventeen reviews were excluded from the study as they did not have keywords. One article was duplicate; therefore, it was excluded as well. There remained 196 articles plus 84 reviews, a total of 280 published materials for the analysis. This manuscript’s selection process of published materials adheres to the applicable PRISMA guidelines. In addition, since there were no human subjects, the author did not need institutional review board (IRB) approval.

In order to examine the differences between published materials in terms of total cited count numbers, independent samples t-tests and one-way Anova test were performed. The independent samples are defined as:

- “National” (if author(s) is/are from one country) vs “International” (if there are at least 2 authors from two different countries);
- “National Single-Centered” (if the author(s) is/are from a single institution in a country vs “National Multi-Centered” (if the authors are from different institutions in a country);
- “Countries Whose Native Language is English” (according to the country of the first author) vs “Countries Whose Native Language is not English” (according to the country of the first author);
- “Periods” according to the publishing time of the studies.

In order to explore the topical differences, the keywords were mapped according to the country of the first author, and the journal. For this purpose, *KNIME* (Knime AG, Zurich, Switzerland), an open-source data analytics software with textual and network analysis capabilities, was used. Additionally, *FactoMineR*, a package of open-source *R* statistical software, was used for correspondence analysis.

RESULTS

In order to address the RQ1, independent samples t-tests and one-way Anova test were performed. Table 1 shows the differences between published materials on COVID-19 in the field of anesthesia in terms of total cited count numbers.

Table 1. Differences between published materials in terms of total cited count numbers.

	Total Number of Published Materials	Total Cited Count Number	Mean ± SD	p
National	219 (%78,2)	6509	29,72±23,11	0,040*
International	61 (%21,2)	2601	42,64±29,76	
Total	280 (%100)	9110	32,53±25,23	
National Single-Centered	93 (%42,5)	2454	26,38±20,10	0,008*
National Multi-Centered	126 (%57,5)	4055	35,59±26,95	
Total	219 (%100)	6509	29,72±20,45	
Review	84 (%30)	3779	44,99±28,86	0,002*
Article	196 (%70)	5331	27,20±21,46	
Total	280 (%100)	9110	32,53±25,23	
Countries whose native language is English	124 (%44,3)	4598	37,09±27,88	0,112
Countries whose native language is not English	156 (%55,7)	4512	28,92±22,34	
Total	280 (%100)	9110	32,53±25,23	
*p<0,05 (independent samples t test)				
December 2019-June 2020	72 (%25,7)	2318	32,19±26,05	0,004*
July 2020- December 2020	118 (%42,2)	4406	37,34±28,22	
January 2021- May 2021	90 (%32,1)	2386	26,51±18,43	
Total	280 (%100)	9110	32,53±25,23	
*p<0,05 (One-way Anova)				

It is found that the mean value of total citations for international publications was higher than national publications and this difference was statistically significant ($p < 0.05$). It is also found that the mean value of total citations for national multi-centered publications was higher than national single-centered publications and this difference was also statistically significant ($p < 0.05$). Reviews were statistically cited more compared to articles ($p < 0.05$). Although the publications written in a country (according to the first author) where English is the native language are cited more compared to the published materials written in a country where English is not the native language, the difference between the citations were statistically not significant ($p > 0.05$). The papers were divided into 3 different periods as time frame. The citations received by the publications in this time period were compared among themselves in pairs. The statistically significant difference came from the comparison between July 2020-December 2020 (mean: 37.34 ± 28.22) and January 2021-May 2021 (mean: 26.51 ± 18.43). Although the publications in the December 2019-Jun 2020 period were the first to be published in the time frame, the comparison of this period with the other two periods was statistically not important.

In order to address the *RQ2*, the descriptive statistics from *KNIME* for the corpus of 280 published materials were obtained. Table 2 shows the distribution of publications in terms of the country of the first author. As can be seen from the table, among 37 countries, the USA was the country with the highest number of publications ($N=39$, 13.93%), followed by England ($N=34$, 12.14%). Results also indicated that the highest percentage (34.64%) of the overall publications originated from the Anglo-American world (USA=13.93%, England=12.14%; Canada=6.07%; Australia=2.5%). India and Germany with 26 and 20 publications respectively, took the 3rd and 4th places.

Table 2. Distribution of published materials by country.

Country	N	%	Country	N	%
USA	39	13,93	Brazil	2	0,71
England	34	12,14	Czech Republic	2	0,71
India	26	9,29	Denmark	2	0,71
Germany	20	7,14	Indonesia	2	0,71
Canada	17	6,07	Iran	2	0,71
Italy	16	5,71	Israel	2	0,71
Spain	15	5,36	Portugal	2	0,71
France	14	5,00	Switzerland	2	0,71
Pakistan	9	3,21	Argentina	1	0,36
Saudi Arabia	9	3,21	Belgium	1	0,36
China	8	2,86	Congo	1	0,36
Japan	8	2,86	Greece	1	0,36
Singapore	8	2,86	Guinea	1	0,36
Australia	7	2,50	Holland	1	0,36
Poland	6	2,14	Ireland	1	0,36
Turkey	6	2,14	Norway	1	0,36
Sweden	5	1,79	Scotland	1	0,36
Egypt	4	1,43	South Korea	1	0,36
Austria	3	1,07			

In further addressing the RQ2, the distribution of published materials in terms of the journals were shown in Table 3.

Table 3. Distribution of published materials by journal.

Journal	N	%	Country	Index	2018 IF
ANAESTHESIA	32	11,43%	England	SCIE	5,879
ANAESTHESIA PAIN & INTENSIVE CARE	19	6,79%	Pakistan	ESCI	N/A
PAIN PHYSICIAN	15	5,36%	USA	SCIE	2,942
REVISTA ESPANOLA DE ANESTESIOLOGIA Y R	14	5,00%	Spain	ESCI	N/A
JOURNAL OF ANESTHESIA	13	4,64%	Japan	SCIE	1,462
SAUDI JOURNAL OF ANAESTHESIA	13	4,64%	Saudi Arabia	ESCI	N/A
ANAESTHESIST	13	4,64%	Germany	SCIE	0,904
INDIAN JOURNAL OF ANAESTHESIA	12	4,29%	India	ESCI	N/A
JOURNAL OF CARDIOTHORACIC AND VASCULAR AN.	11	3,93%	USA	SCIE	1,882
BRITISH JOURNAL OF ANAESTHESIA	11	3,93%	England	SCIE	6,199
ACTA ANAESTHESIOLOGICA SCANDINAVICA	10	3,57%	Denmark	SCIE	2,228
ANAESTHESIA CRITICAL CARE & PAIN MEDICINE	10	3,57%	France	SCIE	2,734
PEDIATRIC ANESTHESIA	9	3,21%	England	SCIE	2,037
CANADIAN JOURNAL OF ANESTHESIA	9	3,21%	Canada	SCIE	3,374
ANAESTHESIOLOGY INTENSIVE THERAPY	8	2,86%	Poland	ESCI	N/A
BEST PRACTICE & RESEARCH-CLINICAL AN.	7	2,50%	England	ESCI	N/A
TURKISH JOURNAL OF ANAESTHESIOLOGY AND R.	6	2,14%	Turkey	ESCI	N/A
JOURNAL OF NEUROSURGICAL ANESTHESIOLOGY	6	2,14%	USA	SCIE	2,957
MINERVA ANESTESIOLOGICA	5	1,79%	Italy	SCIE	2,84
CURRENT OPINION IN ANESTHESIOLOGY	4	1,43%	USA	SCIE	2,102
KOREAN JOURNAL OF ANESTHESIOLOGY	4	1,43%	South Korea	ESCI	N/A
SEMINARS IN CARDIOTHORACIC AND VASCULAR AN.	4	1,43%	USA	ESCI	N/A
TRENDS IN ANAESTHESIA AND CRITICAL CARE	4	1,43%	England	ESCI	N/A
BMC ANESTHESIOLOGY	4	1,43%	England	SCIE	1,619
PAIN MEDICINE	4	1,43%	England	SCIE	2,764
SCHMERZ	3	1,07%	Germany	SCIE	1,267
INDIAN ANAESTHETISTS FORUM	3	1,07%	India	ESCI	N/A
ANESTHESIE & REANIMATION	3	1,07%	France	ESCI	N/A
JOURNAL OF CLINICAL MONITORING AND COMP.	3	1,07%	Germany	SCIE	2,179
INTERNATIONAL JOURNAL OF OBSTETRIC AN.	2	0,71%	England	SCIE	1,958
BRAZILIAN JOURNAL OF ANESTHESIOLOGY	2	0,71%	Brazil	SCIE	N/A
EGYPTIAN JOURNAL OF ANAESTHESIA	2	0,71%	Egypt	ESCI	N/A
PAIN PRACTICE	2	0,71%	USA	SCIE	2,486
REVISTA BRASILEIRA DE ANESTESIOLOGIA	2	0,71%	Brazil	SCIE	0,968
ANNALS OF CARDIAC ANAESTHESIA	2	0,71%	India	ESCI	N/A
PERIOPERATIVE MEDICINE	1	0,36%	England	SCIE	N/A
SOUTHERN AFRICAN J. OF ANAESTHESIA AND A.	1	0,36%	South Africa	ESCI	N/A
AIN SHAMS JOURNAL OF ANESTHESIOLOGY	1	0,36%	Egypt	ESCI	N/A
BJA EDUCATION	1	0,36%	England	ESCI	N/A
SRI LANKAN JOURNAL OF ANAESTHESIOLOGY	1	0,36%	Sri Lanka	ESCI	N/A
ANAESTHESIA AND INTENSIVE CARE	1	0,36%	England	SCIE	1,358
ANESTEZIOLOGIE A INTENZIVNI MEDICINA	1	0,36%	Czech R.	ESCI	N/A
ANASTHESIOLOGIE & INTENSIVMEDIZIN	1	0,36%	Germany	SCIE	0,723
PEDIATRIC ANESTHESIA AND CRITICAL CARE J.	1	0,36%	Italy	ESCI	N/A

Almost one third (33.21%) of all studies were published in the first 5 journals of the list: “*Anaesthesia*”, “*Anaesthesia Pain & Intensive Care*”, “*Pain Physician*”, “*Revista Espanola De Anestesiologia Y Reanimacion*”, and “*Journal of Anesthesia*”. Nine journals had only 1 document each. Two hundred eighty articles/reviews were published in 44 different journals. Twenty-four of these journals were indexed in SCIE and 20 in ESCI. Journals from England are on the top of the list with 11 occurrences, followed by the USA (N=6), Germany (N=4), and India (N=3) in the next three positions. “*Anaesthesia*” from England is on the top of the list with 32 publications. This journal is followed by “*Anaesthesia Pain & Intensive Care*” from Pakistan, “*Pain Physician*” from the USA, “*Revista Espanola De Anestesiologia Y Reanimacion*” from Spain and “*Journal of Anesthesia*” from Japan. Three of these journals are indexed in SCIE and the other two in ESCI.

RQ3 examines the distribution of keywords of the publications. Table 4 shows the most frequently used keywords in 280 publications (N>5). It should be noted that string replacement nodes of *KNIME* was used in order to unify the different writing formats of the same keywords (for example: “Corona Virus”, “Coronavirus”, “Coronavirus-2019”, “Coronavirus Disease 19”, “COVID-19” all were counted as “COVID-19”). As can be seen from Table 4, the most frequent 5 keywords were COVID-19, Sars-cov-2, Pandemic, Anesthesia, and Acute Respiratory Distress Syndrome. It should also be noted that although they may be interchangeably used in many communications, “Sars-CoV-2” is a specific virus that can cause “COVID-19”, a disease. These two keywords constituted 22.79% of all keywords used in 280 published materials.

Table 4. Distribution of keywords (Min= 5).

Keyword	N	%	Keyword	N	%
Covid-19	279	18,70	Telemedicine	8	0,54
Sars-cov-2	61	4,09	Mental Health	7	0,47
Pandemic	39	2,61	Pain Management	7	0,47
Anaesthesia	28	1,88	Aerosol	6	0,40
Acute Respiratory Distress Syndrome	19	1,27	Anxiety	6	0,40
Airway	18	1,21	Education	6	0,40
Critical Care	16	1,07	Pneumonia	6	0,40
Intensive Care	16	1,07	Pregnancy	6	0,40
Personal Protective Equipment	16	1,07	Prone Positioning	6	0,40
Infection	13	0,87	Tracheal Intubation	6	0,40
Mortality	13	0,87	Ventilation	6	0,40
Mechanical Ventilation	11	0,74	Healthcare Worker	5	0,34
Chronic Pain	10	0,67	Lung Ultrasound	5	0,34
Intubation	9	0,60	Pain	5	0,34
Pandemics	9	0,60	Paediatrics	5	0,34
Intensive Care Unit	8	0,54	Training	5	0,34
Respiratory Failure	8	0,54	Viruses	5	0,34

In further addressing RQ3, the distribution of the keywords according to the countries are shown in Figure 2 and according to the journals are shown in Figure 3.

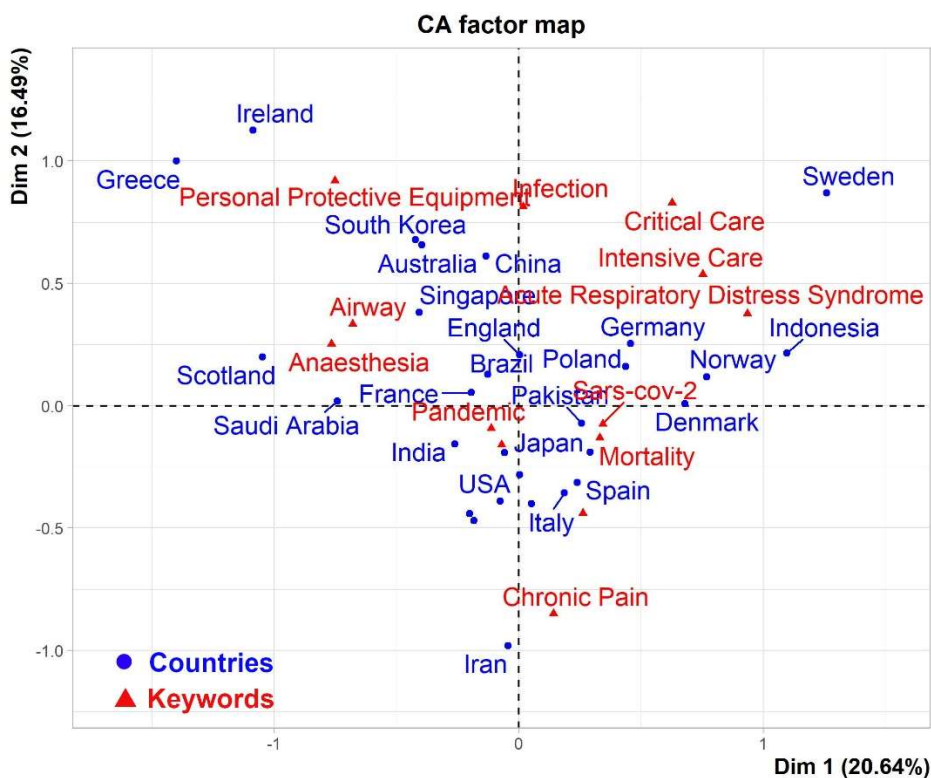


Figure 2. The distribution of keywords according to the countries.

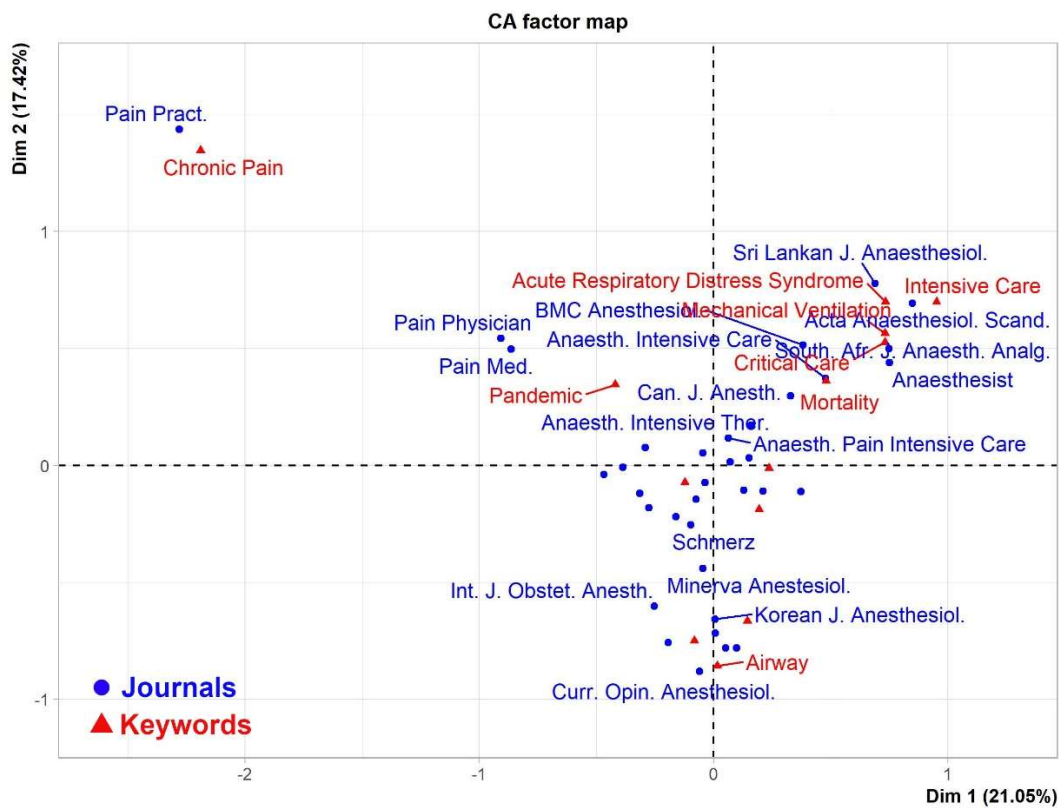


Figure 3. Correspondence analysis of keywords with journals.

The correspondence analysis in *FactoMineR* revealed that Iran, Greece, and Ireland are rather distinct than the other countries in terms of the author keywords (Figure 2). On the other hand, the journal "Pain Practice" is quite distinct from the rest of the journals in terms of the author keywords (Figure 3).

DISCUSSION

COVID-19 is currently a global problem. In order to deal with this problem in the best way possible, a lot of studies have been conducted in different disciplines of medicine, in many countries. Some of these studies are performed in only one country whereas some others are performed with the collaboration of scholars from different countries. It has been a matter of debate whether national publications or international publications receive more citations. A study showed that internationally collaborated papers are getting more citations than national papers [1], whereas some other studies showed a less uniform pattern across countries [2,3] and a study showed that internationalism did not have a considerable citation impact [4]. This study which was conducted on papers about COVID-19 in the field of anesthesia showed that international papers were cited more compared to national (or rather domestic) papers. This could be due to the fact that COVID-19 spread quickly internationally and became a global issue.

In this study, national published materials are divided into two groups as single-centered and multi-centered. It was shown that multi-centered studies (studies that are conducted with the collaborations of authors from at least two different institutions) were cited more compared to single-centered works. Indeed, one another study also showed that interdisciplinary collaboration between institutions increased citation rates whereas single centered studies (or in other words in-house collaboration) reduced them [5]. Likewise, another study also suggested that multiple author affiliations from different institutions could play a positive role in increasing the citation rates [6]. Needless to say, worthwhile to mention, more studies should be conducted to understand the impact of multiple author affiliations on the citation rates.

The papers published in the period July 2020-December 2020 were cited more when compared with other two periods. One could argue that the papers published in the period December 2019-June 2020 could have received more citations as they were the oldest publications on COVID-19 in the field of anesthesia but that was not the case in this study. This could be due to the fact that, as time passed more information was gathered about COVID-19 and authors of lately published materials wanted to make use of the most recent works.

In assigning the publications' countries, there does not seem to be a consensus in the literature. There are some studies that assign the country of a publication according to the corresponding author [7,8] whereas some studies have used the first author to make the country allocation [9,10]. It is also interesting to see that some other studies did not mention how the country of a particular publication was determined [11–13]. In this study, it was decided to use the country of the first author as some scholars suggest that the first author is generally the one who contributes the most to a study [14].

Another study that analyzed the publications about COVID-19 in the field of anesthesia could not be found. Therefore, to make country-wise comparisons, previous bibliometric studies about COVID-19 were looked for. In a study that was accepted as early as in March 2020, Chahrour et al. found 1809 published materials but analyzed only 564 which met their inclusion criteria. Those came from 39 different countries. China produced the highest number of academic output, followed by the USA, Japan, England, Australia, and Italy [15]. In De Felice et al.'s study, China and the USA were the first and second ranked countries respectively, this time followed by England, Italy, and France. In that study, which was accepted in May 2020, the researchers used the Scopus database and found that there were 94 different countries that produced a total of 1883 published materials [16]. In another study that was accepted in June 2020, out of 15805 academic materials on the topic of COVID-19, the ranking of the countries in terms of the number of published materials came out as: China, the USA, England, Italy, Canada, and Germany [17]. In all three of above-mentioned studies, China ranked first, followed by the USA for the greatest academic output. This result may not be surprising when one thinks that the first Corona case was reported in China in December 2019.

In another study that was accepted in July 2020, the researchers observed another country on the top of the list in number of published materials on the topic of COVID-19, which was the USA, followed by China, Italy, the UK, India, and France [18]. In fact, when four other bibliometric studies were checked in anesthesia discipline, the USA dominated all the other countries in terms of number of published materials; there were six different countries in the following four positions though being in different rankings in those studies. These countries were Germany, England, France, Japan, Canada, and Turkey [8,13,19,20]. In this study, the USA (N=39, 13.93%) was the country that published the most on the topic of COVID-19 in the field of anesthesia. 2 articles from Wales were grouped as England; Swaminathan et al. also did a similar grouping in their research [20]. The next four countries were England (N=34, 12.14%), India (N=26, 9.29%), Germany (N=20, 7.14%), and Canada (N=17, 6.07%) respectively. This ranking is quite consistent with previous bibliometric analysis researches that were examined.

The fact that 34.64% of the overall publications originated from Anglo-American countries in this study, could be explained with the results of previous studies of bibliometric analysis. One study found that the academic output is significantly related with gross domestic product and human development index [11]. The significant linkage between economic development of a country and academic output is also supported by the results of some other studies [8,9,13]. In this study, 280 articles/reviews were published in 44 different journals. Most of the journals were included in Doğan and Karaca's work where the authors made a bibliometric analysis of the field of anesthesia between 2009-2018 [13]. This is not surprising since research related to COVID-19 in the field of anesthesia is most likely to be published in anesthesiology journals. Almost half of the researchers from Canada had their works published in journals outside their country as there was only one Canadian journal that published COVID-19 and anesthesia related studies. Saudi Arabia ranked tenth in terms of number of published materials; it was found that there was only one journal from that country. That particular journal published 13 articles/reviews of which 8 were authored by researchers from Saudi

Arabia, 3 were from India and 2 were from the USA. This is not exactly the case for “Anaesthesia Pain & Intensive Care” journal from Pakistan as that journal published 19 works; 9 from Pakistan and the remaining 10 were from 8 different countries.

Studies that include bibliometric analysis often make use of keywords in order to disclose the state of knowledge about a specific subject; these studies also indicate a direction for further research as they can show the knowledge structure of particular categories of research [21]. One of the methods of bibliometric analysis is to look for occurrence of the keywords in different publications. Keyword frequency analysis can be used to reveal current trends as well as revealing the historical hotspots for different fields of research [22,23]. It can also provide supplementary provision for scientific research [24]. Large occurrence of particular keywords can show that authors intensively researched certain parts of a scientific discipline. On the other hand, low frequency of some keywords may mean that there is a lack of continuity, or that further research is needed on the subject [23,25]. Keywords analysis can also show different networks or clusters around the world that focus on certain scientific issues. It is certainly a practical tool to make the intellectual structure of a certain discipline more visible and understandable, and a longitudinal approach can show hints of the changes in different time series [26]. In this study's keyword analysis, terms specific to the virus such as COVID-19, Sars-cov-2 and Pandemic were the most frequently used. When the words specific to the field of anesthesia were examined, words such as Airway, Acute Respiratory Distress Syndrome, Intubation, Mechanical Ventilation, and Mortality were frequently encountered. Airway control and intubation are among the main duties of anesthesiologists; therefore, these two words might have been recurrently used as keywords. Acute Respiratory Distress Syndrome (ARDS) is a disease that occurs mostly due to viral infections [27]. It is one of the most common conditions for intensive care patients yet it brings in many difficulties for anesthesiologists during the pandemic, as the presence of this syndrome is an important factor in determining the treatment protocol of new Corona virus-infected patients [28,29]. This could explain the frequent occurrence of ARDS in keywords.

Telemedicine was one of the least used keywords. Neither operating rooms nor intensive care units are suitable for remote services. Anesthesiologists should see the patients in person before an operation to make critical assessments. Likewise, the assessment to admit a patient into intensive care unit cannot be done remotely. Only algology related units might provide remote service with telemedicine. For this reason, it is likely that telemedicine is a keyword that is rarely mentioned in published materials. In De Felice and Polimeni's analysis, words related to the new coronavirus and the definition of it were frequently used such as: Sars-Cov-2, 2019-ncov, COVID-19, Pandemic, Novel Coronavirus. Other than these, frequent occurrence of the word pneumonia was observed in their study. Likewise, the word ARDS was one of the most used keywords in anesthesia related COVID-19 publications [16]. Therefore, one could conclude that the most severe problem caused by the virus could have been damage to the lungs. In this study, it was found that many articles/reviews included common keywords such as COVID-19, Sars-cov-2, Pandemic, Critical care, Airway, and Anesthesia. In addition, when the keywords were analyzed according to the countries of

articles/reviews, some uncommon keywords were noticed. For example, the word Pediatrics was used the most in articles/reviews from the USA. There is another study that supports this finding; the USA has the highest number of publications about pediatrics [30]. According to keyword analysis, it could also be claimed that some published materials from the USA examined the coagulation system since keywords such as Trombectomy and Stroke were used. Chinese scholars, on the other hand, were more interested in occupational health compared to other scholars from the world. They were concerned that health care workers are at increased risk of diseases caused by the virus, hence, they published about occupational health issues [31].

When the published materials from England were examined, keywords that are more specific such as Laryngeal Synechia and Vocal Cord Synechia were observed. These symptoms are observed in patients with prolonged intubation and unfortunately, they increase mortality rates. British scholars studied on these particular issues and their works were published in *“Trends in Anaesthesia and Critical Care”* journal. It was also observed that this journal gave priority to the issues of Vocal Cord Adhesion, Laryngeal Adhesion, and Laryngeal Injury. In fact, tracheostomy is a common practice for patients who experience long-term mechanical ventilation and have severe lung diseases. However, since tracheostomy is a droplet-emitting process, this controversial issue in terms of COVID-19 has been widely discussed in works from England. One of the keywords frequently mentioned in published materials from Canada was Steroids. The use of steroid therapy in intensive care diseases such as ARDS and sepsis has been a topic of discussion for a long time. During the COVID-19 pandemic, this discussion continues at full speed [32,33]. Waist, back, chest, and widespread body pain are common and long-lasting for COVID-19 patients. It was observed that Canadian authors publish quite often about chronic pain and their works were mostly presented in Indian journals.

There are limitations in this study. Web of Science database was used to identify the publications. Similar searches in some other reputable databases such as Scopus, PubMed or World Health Organization’s database could have given different results. Although document types of letters, editorials, and news items were excluded from this study, they also contribute a lot to literature. But for the scope of this study, the documents that had keywords had to be included and many of the letters, editorials or news items do not have keywords. Another limitation is the fact that the countries and journals were classified on the basis of numbers of published materials.

CONCLUSIONS

The USA, England, India, and Germany were the leading countries in numbers of published materials about COVID-19 in the field of anesthesia. *“Anaesthesia”*, *“Anaesthesia Pain & Intensive Care”*, and *“Pain Physician”* were the top three journals in terms of the numbers of articles/reviews about COVID-19 in anesthesia. The keywords distribution of the countries varied according to the priorities of each country. However, the keywords that were most commonly used were COVID-19, Sars-cov-2, Pandemic, Anesthesia, and Acute Respiratory Distress Syndrome. Keywords analysis showed that although some keywords were used more frequently than the others, research about COVID-19 in the field of anesthesia was quite diverse.

This paper not only showed the features of papers that are cited more but also showed the ranking of countries that contribute the most to the literature and reflected the hot topics about COVID-19 in the field of anesthesia. Extensive studies about COVID-19 have already begun, and the number of studies keep increasing. Therefore, this study could provide hints for authors who would like their papers to be cited more as well as useful information for further research.

SUPPLEMENTARY INFORMATION

Funding: This research received no external funding.

Institutional Review Statement: The study was conducted according to the guidelines of the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

REFERENCES

- [1] Katz JS, Hicks D. How much is a collaboration worth? A calibrated bibliometric model. *Scientometrics* 1997; 40(3): 541–554.
doi: <https://doi.org/10.1007/BF02459299>
- [2] Persson O. Are highly cited papers more international? *Scientometrics* 2010;83(2): 397–401.
doi: <https://doi.org/10.1007/s11192-009-0007-0>
- [3] Tijssen RJW, Visser MS, Van Leeuwen TN. Benchmarking international scientific excellence: Are highly cited research papers an appropriate frame of reference? *Scientometrics* 2002; 54(3): 381–397.
doi: <https://doi.org/10.1023/A:1016082432660>
- [4] Van Leeuwen TN. Strength and weakness of national science systems: A bibliometric analysis through cooperation patterns. *Scientometrics* 2009; 79(2): 389–408.
doi: <https://doi.org/10.1007/s11192-009-0426-y>
- [5] Leimu R, Koricheva J. Does scientific collaboration increase the impact of ecological articles? *Bioscience* 2005; 55(5): 438–443.
doi: [https://doi.org/10.1641/0006-3568\(2005\)055\[0438:DSCITI\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2005)055[0438:DSCITI]2.0.CO;2)
- [6] Sanfilippo P, Hewitt AW, Mackey DA. Plurality in multi-disciplinary research: multiple institutional affiliations are associated with increased citations. *PeerJ* 2018; 6:e5664.
doi: <https://doi.org/10.7717/peerj.5664>
- [7] Pagel PS, Hudetz JA. A bibliometric analysis of geographic publication variations in the journal of cardiothoracic and vascular anesthesia from 1990 to 2011. *J Cardiothorac Vasc Anesth.* 2013; 27(2): 208–212.
doi: <https://doi.org/10.1053/j.jyca.2012.08.022>
- [8] Bould MD, Boet S, Riem N, Kasanda C, Sossou A, Bruppacher HR. National representation in the anaesthesia literature: A bibliometric analysis of highly cited anaesthesia journals. *Anaesthesia* 2010; 65(8): 799–804.
doi: <https://doi.org/10.1111/j.1365-2044.2010.06424.x>
- [9] Wang JO, Chen TJ, Kao S, Yeh TC, Chou LF, Ho ST. Scientific publications by anesthesia departments in East Asia. *Scientometrics* 2012; 92(1): 135–143.
doi: <https://doi.org/10.1007/s11192-012-0717-6>

- [10] Yılmaz HO, Babazade R, Turan OA, Babazade B, Koyuncu O, Turan A. Scientific publication performance of Turkish anaesthesia clinics in high impact factor International Journals Between 2005 and 2014: A Bibliometric Analysis. *Turkish J Anaesthesiol Reanim.* 2017; 45(1): 16–25.
doi: <https://doi.org/10.5152/tjar.2016.16680>
- [11] Ozsoy Z, Demir E. The evolution of bariatric surgery publications and global productivity: a bibliometric analysis. *Obes Surg.* 2018; 28(4): 1117–1129.
doi: <https://doi.org/10.1007/s11695-017-2982-1>
- [12] Doğan G, İpek H. The Development of Necrotizing Enterocolitis Publications: A Holistic Evolution of Global Literature with Bibliometric Analysis. *Eur J Pediatr Surg.* 2020; 30(3): 293–303.
doi: <https://doi.org/10.1055/s-0039-3400514>
- [13] Doğan G, Karaca O. A bibliometric analysis of the field of anesthesia during 2009–2018. *Rev Bras Anesthesiol.* 2020; 70(2): 140–152.
doi: <https://doi.org/10.1016/j.bjan.2020.02.003>
- [14] Riesenber D, Lundberg GD. The Order of Authorship: Who's on First? *JAMA.* 1990; 264(14): 1857.
doi: <https://doi.org/10.1001/jama.1990.03450140079039>
- [15] Chahrour M, Assi S, Bejjani M, Nasrallah AA, Salhab H, Fares MY, et al. A Bibliometric Analysis of COVID-19 Research Activity: A Call for Increased Output. *Cureus* 2020; 12(3): e7357.
doi: <https://doi.org/10.7759/cureus.7357>
- [16] De Felice F, Polimeni A. Coronavirus disease (COVID-19): A machine learning bibliometric analysis. *In Vivo .* 2020; 34(3 Suppl): 1613-1617.
doi: <https://doi.org/10.21873/invivo.11951>
- [17] Yu Y, Li Y, Zhang Z, Gu Z, Zhong H, Zha Q, et al. A bibliometric analysis using VOSviewer of publications on COVID-19. *Ann Transl Med.* 2020 ;8(13): 816–816.
doi: <https://doi.org/10.21037/atm-20-4235>
- [18] Zyoud SH, Al-Jabi SW. Mapping the situation of research on coronavirus disease-19 (COVID-19): A preliminary bibliometric analysis during the early stage of the outbreak. *BMC Infect Dis.* 2020; 20(1): 561.
doi: <https://doi.org/10.1186/s12879-020-05293-z>
- [19] Schreiber K, Girard T, Kindler CH. Bibliometric analysis of original molecular biology research in anaesthesia. *Anaesthesia* 2004; 59(10): 1002–1007.
doi: <https://doi.org/10.1111/j.1365-2044.2004.03873.x>
- [20] Swaminathan M, Phillips-Bute BG, Grichnik KP. A bibliometric analysis of global clinical research by anesthesia departments. *Anesth Analg.* 2007; 105(6): 1741-1746.
doi: <https://doi.org/10.1213/01.ane.0000286149.57763.e7>
- [21] Su HN, Lee PC. Mapping knowledge structure by keyword co-occurrence: A first look at journal papers in Technology Foresight. *Scientometrics* 2010; 85(1): 65–79.
doi: <https://doi.org/10.1007/s11192-010-0259-8>
- [22] Chen G, Xiao L. Selecting publication keywords for domain analysis in bibliometrics: A comparison of three methods. *J Informetr.* 2016; 10(1): 212–223.
doi: <https://doi.org/10.1016/j.joi.2016.01.006>
- [23] Riesenber D, Lundberg GD. The Order of Authorship: Who's on First? *JAMA.* 1990; 264(14): 1857.
doi: <https://doi.org/10.1001/jama.1990.03450140079039>
- [24] Tan J, Fu HZ, Ho YS. A bibliometric analysis of research on proteomics in Science Citation Index Expanded. *Scientometrics* 2014; 98(2): 1473–1490.
doi: <https://doi.org/10.1007/s11192-013-1125-2>
- [25] Zhu W, Guan J. A bibliometric study of service innovation research: Based on complex network analysis. *Scientometrics* 2013; 94(3): 1195–1216.
doi: <https://doi.org/10.1007/s11192-012-0888-1>

- [26] Ding Y, Chowdhury GG, Foo S. Bibliometric cartography of information retrieval research by using co-word analysis. *Inf Process Manag.* 2001; 37(6): 817–842.
doi: [https://doi.org/10.1016/S0306-4573\(00\)00051-0](https://doi.org/10.1016/S0306-4573(00)00051-0)
- [27] Kalil AC, Thomas PG. Influenza virus-related critical illness: pathophysiology and epidemiology. *Crit Care* 2019; 23(1): 258.
doi: <https://doi.org/10.1186/s13054-019-2539-x>
- [28] Li X, Ma X. Acute respiratory failure in COVID-19: Is it “typical” ARDS? *Crit Care* 2020; 24(1): 198.
doi: <https://doi.org/10.1186/s13054-020-02911-9>
- [29] Ferrando C, Suarez-Sipmann F, Mellado-Artigas R, Hernández M, Gea A, Arruti E, et al. Clinical features, ventilatory management, and outcome of ARDS caused by COVID-19 are similar to other causes of ARDS. *Intensive Care Med.* 2020; 46(12): 2200–2211.
doi: <https://doi.org/10.1007/s00134-020-06192-2>
- [30] Doğan G, Doğan G. Statistical Analysis of Covid-19 Publication in the Fields of Pediatrics. *Kırıkkale Üniversitesi Tıp Fakültesi Derg.* 2020; 22(2): 254–262.
doi: <https://doi.org/10.24938/kutfd.769806>
- [31] Koh D. Occupational risks for COVID-19 infection. *Occup Med (Lond)* 2020; 70(1): 3-5.
doi: <https://doi.org/10.1093/occmed/kqaa036>
- [32] Sterne JA, Murthy S, Diaz J V, Slutsky AS, Villar J, Angus DC, et al. Association between Administration of Systemic Corticosteroids and Mortality among Critically Ill Patients with COVID-19: A Meta-analysis. *JAMA - J Am Med Assoc.* 2020; 324(13): 1330–1341.
doi: <https://doi.org/10.1001/jama.2020.17023>
- [33] Halpin DMG, Singh D, Hadfield RM. Inhaled corticosteroids and COVID-19: A systematic review and clinical perspective. *Eur Respir J.* 2020; 55(5): 2001009.
doi: <https://doi.org/10.1183/13993003.01009-2020>