Between panic and motivation: did the first wave of COVID-19 affect scientific publishing in Mediterranean countries?

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Abstract
Due to the ongoing COVID-19 pandemic that began in the winter of 2020, all communities and activities globally have been positively or negatively affected. This scientometric study raises an interesting question concerning whether the volume and characteristics of scientific publishing in all disciplines in 23 Mediterranean countries have been impacted by the pandemic and whether variations in the cumulative totals of COVID-19 cases have resulted in significant changes in this context. The Scopus database and SciVal tool supplied the necessary data for the years targeted for comparison (2019 and 2020), and the annual growth rates and differences were computed. The study used the Mann–Whitney test to examine the significance of the differences between the two years and the Spearman and Kendall correlation tests to evaluate the effect of the number of infections on these differences for all aspects of scientific performance. The findings demonstrated that the COVID-19 pandemic served as a powerful incentive, and the Mediterranean region experienced considerable differences in the volume and features of publications during this crisis. The most substantial implications were the significant growth from 3.1 to 9.4% in productivity and the increases in the annual growth rates of international collaboration, by 12% for the collaboration among Mediterranean countries and 10% for collaboration with the top ten epidemic countries. It was also proven that some characteristics of the publications were positively correlated with the total number of infections. This investigation can help university leaders and decision-makers in higher education and research institutions in these countries make decisions and implement measures to bridge the gaps and motivate researchers in all fields to conduct more research during this ongoing pandemic.

Keywords COVID-19 · Scientometrics · Bibliometrics · Scientific publishing · Research analysis · Research performance · Mediterranean countries · Crisis

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Introduction

Since COVID-19 was declared a Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) on January 30, 2020 (World Health Organization, 2020b), diverse occupations and activities have been dramatically impacted globally, such as business organizations (Seetharaman, 2020), creative and cultural industries (Comunian & England, 2020), and self-employed workers (Beland et al., 2020). The active case count, physical distancing, isolation, workplace lockdowns, and transcendent family care have been highlighted as influences controlling workability and productivity during the COVID-19 pandemic (Craig & Churchill, 2020; Czymara et al., 2020; Dey et al., 2020; McIntyre & Lee, 2020; Truxillo et al., 2020). Several psychological studies have revealed high rates of generalized anxiety, depressive symptoms, and fear of the virus, which were mostly related to increased preventive procedures against the virus (Bäuerle et al., 2020; French et al., 2020; Huang & Zhao, 2020; Wong et al., 2020).

Academics and faculty have largely been affected by the lockdown in terms of work time, housework routines, and childcare (Yildirim and Eslen-Ziya), and generalized anxiety disorder has been evident in this group during the COVID-19 outbreak (Huang & Zhao, 2020). Additionally, the digital pedagogies provided by their institutions have caused professional and personal disruptions (Watermeyer et al., 2020). They have further suffered from obstacles, such as the complete closure of libraries or reductions in their hours of operation (Fasae et al., 2020; Kosciejew, 2020), the inability of libraries to completely take advantage of social media to provide their services (Koulouris et al., 2020), and, finally, challenges in the access and usage of digital resources (Hendal, 2020; Mehta & Wang, 2020; Pokorna et al., 2020; Saavedra-Alamillas et al., 2020). As a result, some predict that, given the stark difference between the pre-COVID-19 environment and the post-COVID-19 world, scientific publishing (SP) and all related stakeholders will be significantly affected (Chung et al., 2020; Derrick, 2020; Kim, 2020). However, there is an expectation that unprecedented opportunities will inspire multiple researchers to investigate many facets of this crisis (da Silva et al., 2020).

Accordingly, current research hypothesizes that this health crisis had an impact on the volume and characteristics of SP in all disciplines during the first year of the COVID-19 pandemic. The focus here was on Mediterranean countries (MCs), where the author lives; these countries are marked by a wide disparity in both research production levels and infection totals, which allows for a rich comparison to realize the impact of the pandemic on scientific performance. Furthermore, this region, which includes countries located on three continents (Europe, Africa, and Asia), can represent a sample of the global situation in terms of outbreak levels and research outputs. The objectives are to (1) investigate whether there is a significant difference between the year prior to COVID-19 (2019) and the first year of the COVID-19 outbreak (2020) with regard to the annual growth rate (AGR) of SP and international collaboration (IC) as well as other characteristics, including disciplines-languages-types-rankings of journals, and (2) to explore the correlations between the cumulative totals of COVID-19 cases and SP and its characteristics.

In response to the enormous growth of scientific work associated with the novel virus, many scientometric studies have been conducted to trace the evolution of this work and its various aspects. Changes in research performance across all fields during the initial stage of the pandemic were not adequately investigated. Most analyses have focused only on the health sciences, and other disciplines were disregarded. A few studies examined the correlation between only the initial COVID-19 publications and
the level of the outbreak as measured by the number of cases. Nonetheless, previous research served as an inspiration for the current investigation by outlining the key pillars that should be examined, including differences in both the volume of research and its various features, as well as their relationships with COVID-19 cases.

Some investigations highlighted the contributions of different countries and regions to COVID-19 research outputs during the first year of the pandemic. After striving to map the COVID-19 publications globally, Belli et al. (2020) found that the largest contributions were made by the United States and China. This result has been confirmed by Sahoo and Pandey (2020), Lan et al. (2020), Herrera-Viedma et al. (2020), Ho and Liu (2021), and Usman and Ho (2021). A literature review by Benjamens et al. (2020) revealed that Europe ranked first among all continents, accounting for 47.7% of the research published in four major medical journals, followed by North America, with 37.3. The types and languages of publications were also examined; research articles were the leading type, and most of the publications were published in English (da Silva et al., 2020; Al-Zaman, 2021). According to Ebadi et al. (2020), “intelligent systems”, “tools to predict”, and “diagnose COVID-19” were the most-researched areas from January to May 2020. A longer time span was analysed by Herrera-Viedma et al. (2020), who revealed an increasing volume of publications and citations related to coronavirus from 1970 to April 2020. Focusing only on nursing journals, Oh and Kim (2020) found that 60% of COVID-19 papers were published in first-quartile journals indexed in the Web of Science.

From another perspective, some researchers attempted to determine the motives for the unexpected and growing volume of COVID-19-related studies. Ho and Liu (2021) found that the most highlighted motive was the various platforms provided by the most prestigious medical journals to access the relevant outputs. Nevertheless, there are worries about the quality of this volume, which has been discussed in several studies. The analysis of papers published on PubMed and the Rxiv preprint server by Homolak et al. (2020) revealed that the drastic reduction in the time taken for editing and peer-review work during COVID-19 has necessarily affected the content quality, and there will be a need to re-review these papers later. No novel information was presented in the initial COVID-19 literature; this was inferred by Di Girolamo and Reynders (2020) after distinguishing the primary from the secondary articles indexed in PubMed. The evaluation by Pal (2021) found that the global research outburst on COVID-19 had a growth rate of 1600%. Dinis-Oliveira (2020) used the term “paperdemic” to describe this accelerated publication rate and its harmful impacts on science. To emphasize these side effects, Fernandez-Cano (2021) titled his letter to the editor ”publish, publish… cursed!”.

In this vein, a commentary by Moradi and Abdi (2020) noted multiple corrections and erratum published regarding the significantly increased volume of COVID-19 publications. This volume also yielded several retractions, the reasons for which were mostly problems with the results, conclusions, and data (Soltani & Patini, 2020).

To the best of my knowledge (until June 2021), there is no study revealing the differences in scientific progress in all disciplines that occurred as a result of the pandemic or their correlations with the levels of the outbreak worldwide, in general, and in the Mediterranean region, in particular. The current research addresses this research gap by demonstrating how the crisis has impacted research performance in this region. This paper is the first cross-sectional comparative analysis to reveal the correlation between COVID-19 case totals and scientific progress in all disciplines (Physical Sciences, Health Sciences, Social Sciences, Life Sciences, Multidisciplinary).
Methods

Required data and sources

Three types of data about the MCs were collected to examine the research hypothesis.

The Mediterranean countries

One of the main difficulties concerning the identification of the countries in the Mediterranean region was the absence of an official government entity to identify those countries. Only the Union for the Mediterranean was found. This is an entity that unites many Mediterranean countries alongside other European countries (Union for the Mediterranean, 2020), which was not adequate for the present study. By browsing online maps of the Mediterranean region and picking the most accurate map and after seeking the advice of two experts in geopolitics,¹ it was concluded that this region includes 23 countries bordering the Mediterranean coast (Nations Online, 2020).

The cumulative totals of COVID-19 cases

The reported COVID-19 cases were acquired to examine their correlation with the volume and characteristics of SP. Cases were considered rather than deaths, although the actual number of COVID-19 cases may be higher than the recorded number due to factors related to the national health systems, such as the cost and extent of COVID-19 test availability (Dil et al., 2020). This is because the number of cases is the key indicator of the outbreak of the virus, as the WHO declared COVID-19 to be a PHEIC after the virus rapidly spread with a continued increasing number of confirmed cases. Furthermore, the number of cases often includes the number of deaths, which is recorded as cases before death. This is in line with initial scientometric studies on COVID-19, which have mentioned the number of cases (Di Girolamo & Reynders, 2020; Zhang et al., 2020). The WHO website was used to extract the cumulative totals of COVID-19 cases in the MCs from March 31, 2020 (the first date cases were recorded by the site), to December 31, 2020, which were announced on Jan. 1, 2021. Figure 1 demonstrates the distribution of cases in the 23 MCs. Additionally, the totals of the top 10 countries worldwide in terms of the number of cases were extracted to examine the IC between the MCs and those countries, including the United States of America, India, Brazil, Russia, France, the United Kingdom, Italy, Spain, Germany, and Colombia (World Health Organization, 2021) (see Online Resource 1, A). The number of cases represents the study’s independent variable, the impact of which on the volume and characteristics of SP is measured.

The volume and characteristics of SP

Both Elsevier’s Scopus and Clarivate Analytics’ Web of Science are major sources that bibliometricians often consult. To fulfil this paper’s objectives, it was more appropriate to use Scopus because of its wider publication coverage in all disciplines and wider language

¹ Prof. Syed Abdul Khaleque, Dr. Islam El Noby, Geographic Information Systems Dep., Helwan University.
coverage and because it is more up to date in indexing publications on COVID-19 (Belli et al., 2020; da Silva et al., 2020; Haghani & Bliemer, 2020; Mongeon & Paul-Hus, 2016). Furthermore, SciVal, a web-based analytics solution from Elsevier assisting those who evaluate research engagement and impact worldwide (Elsevier 2021a, 2021b), was used as an advantageous tool accessed through Scopus to obtain on-demand tailored reports for the target region. As depicted in Fig. 2, SciVal and Scopus were used for specific purposes. SciVal was first utilized to create the Mediterranean region based on a request sent by the author on Dec. 25, 2020, and it was constructed by the tool on Dec. 28, 2020. Additionally, it was used to extract the totals of both SP and IC, including the IC among MCs and the IC between the MCs and the top ten epidemic countries. To prevent data duplication, France, Italy, and Spain were excluded from the top ten list because they already belong to the MCs. In addition, SciVal helped to retrieve the region’s SP characteristics by subject area, type, and journal ranking. Scopus was favoured in some search strategies because it has certain functionalities that SciVal lacks, such as the ability to use Boolean search operators to gather items related to the topic of COVID-19 in the main subject areas and medical specialties, as well as the ability to filter by language. Data for comparison between two years were needed (one-year pre-COVID-19, from January 1 to December 31, 2019, and during the first year of the COVID-19 period, from January 1 to December 31, 2020). The 2018 data were generated only to calculate the AGR of the SP volume and IC for 2019. Unquestionably, it is more efficient to capture all the data in one day to avoid database updates. However, owing to the large volume and diversity of the required data, they were extracted from January 17 to February 27, 2021, which was the shortest possible period available to the author. Moreover, given that the data collected were retrospective, it was taken into consideration that update opportunities would be rare, especially since SciVal, from which most of the data were extracted, is updated weekly every Tuesday.

There are further considerations as follows: (1) The main subject areas in both SciVal and Scopus include "Physical Sciences" (11 sub-areas), "Health Sciences" (6 sub-areas),
"Social Sciences" (7 sub-areas), and "Life Sciences" (6 sub-areas). Each subject area has a sub-area called "multidisciplinary". When extracting data related to publications categorized under these main areas, a subject area filter was used. It considers "multidisciplinary" an independent subject area that includes all publications classified under "multidisciplinary" included in the four subject areas. (2) Since one document can be classified under more than one subject area, this led to higher totals for the subject area distribution than the totals of documents according to country. (3) Regarding the ten medical specialties related to COVID-19 listed by (Zhang et al., 2020), each specialty was embedded in the relevant search strategy with the main keywords of COVID-19 and coronavirus, for example, “COVID-19” or “coronavirus” and “virology”. For dual disciplines such as “Pharmacology & Pharmacy”, they were divided into two terms as follows: “COVID-19” or “coronavirus” and “Pharmacy”/“COVID-19” or “coronavirus” and “Pharmacology”.

### Statistical analysis tests

To measure the growth rates for the target years (2019, 2020), the AGR of both SP and IC in the MCs was calculated by the following equation for two periods (2018–2019 and 2019–2020) for every country. The AGR is a measurement used to express a year-on-year growth.

| Source | Dataset | Search Strategy | Date |
|--------|---------|-----------------|------|
| SCIVAL | SP of the MCs (C by C) in 2018, 2019, 2020. | Overview → Mediterranean region → Country → Publication year | 17-01-2021 |
|        | SP of the MCs (C by C) according to the main subject areas in 2019. | Overview → Mediterranean region → Subject areas → Publication year → Country | From 23-02-2021 to 27-02-2021 |
|        | SP of the MCs (C by C) according to the publication type in 2019, 2020. | Overview → Mediterranean region → Type → Publication year → Country | From 19-01-2021 to 24-01-2021 |
|        | International collaboration among the MCs (C by C) in 2018, 2019, 2020. | Collaboration → Country → Collaborated Mediterranean countries → publication year | |
|        | International collaboration between the MCs (C by C) and the top ten epidemic countries according to the COVID-19 cases worldwide in 2018, 2019, 2020. | Collaboration → Country → The top 10 countries → publication year | |
|        | Ranking of journals (C by C) in 2019, 2020. | Overview → Country → Published → Journal quartile → Publication year | 18-01-2021 |

**Fig. 2** A Flowchart of the implementation of the search strategies adopted to extract the requisite data sets from SciVal and Scopus. * C by C = country by country
change in a variable as a percentage. It can be beneficial in assessing performance in any activity to monitor success or failure.

\[
AGR = \frac{\text{End Value} - \text{First Value}}{\text{First Value}} \times 100
\]

The differences between the AGRs of the two years were calculated for every country:

\[
\text{Difference of AGR} = 2020AGR - 2019AGR
\]

To study the effect of COVID-19 on the SP characteristics, the difference for each characteristic between the two years was calculated for every country.

\[
\text{Difference in characteristic} = \sum 2020 - \sum 2019
\]

Two-sample hypothesis testing was used to determine if there was a significant difference between the two years. Initially, Shapiro–Wilk and Kolmogorov–Smirnov normality tests were used to determine whether to use parametric or non-parametric tests based on the data’s normality (Razali & Wah, 2011). Then, because all of the difference values were non-normal distributed, the analysis depended on the non-parametric Mann–Whitney test (Nachar, 2008) to examine the impact of COVID-19 on the calculated AGRs and SP characteristics. Additionally, correlation tests were performed to determine whether there was a positive or negative correlation between the differences calculated and the cumulative totals of COVID-19 cases in MCs. Since the data did not have a normal distribution, the non-parametric Spearman and Kendall correlations (Croux & Dehon, 2010) were used. The significance level was 10% for all tests.

Applications and illustration design

The analysis was performed by IBM-SPSS, version 20, and all extracted test values are grouped in (Online Resource 1, B). The tables and figures were designed using Microsoft Excel 2010. All MCs are ranked in all tables in descending order based on the number of infections, and the continent symbol for each country is added in all the tables (Africa, AF; Asia, AS; Europe, EU). Regarding the meaning of the values in the charts, the positive values indicate an increase in the SP during the spread of COVID-19, while the negative values reflect its decrease. Further, the map of MCs infections was generated by ArcGIS Pro, version 10.5, Esri Inc. To distinguish the MCs, they were classified into three categories according to the recorded cases as follows: high (red), >400,000; moderate (yellow), 100,000–400,000; and low (green), <100,000.

Results

This analytical section highlights the most important findings regarding the quantitative and qualitative characteristics of SP in MCs before and during the first year of the COVID-19 pandemic. It further measures the correlations between those characteristics and the number of cases recorded in the countries surveyed. The following are the results presented according to the core questions of the study.
Are there significant differences between 2019 and 2020 in terms of the AGR of SP? Are they affected by the number of COVID-19 cases?

It is remarkable that the details provided in Table 1 regarding infection count and SP volume reveal that while France, Italy, and Spain ranked first among the MCs, Gibraltar and Monaco occupied the bottom of the list. For AGR, there was a dramatic difference, as the overall AGR of SP jumped from 3.1 to 9.4% in the first year of the COVID-19 outbreak (2020). Although the AGR dropped in eight countries, it rose in the remaining countries (Fig. 3). Algeria and Monaco had the lowest AGRs, with decreases of approximately 19% and 15%, respectively. Gibraltar had the largest AGR (262%), despite its production remaining low. This is because the AGR equation yields a percentage of an increase or decrease in publications, regardless of the volume of publications itself. Hence, the AGR achieved by this country means that its production rose by a high percentage after COVID-19, regardless of the volume of its production. On the other hand, the small AGR values in other countries (positive or negative) indicated that publications increased or declined by a low percentage. The p-value of the Mann–Whitney test was 0.106; accordingly, there was a significant difference in the AGR between 2019 and 2020. The medians of the two years were 8.73% and 11.80%, respectively. Hence, the AGR of the SP increased during the spread of COVID-19. Contrary to expectations, the number of COVID-19 cases did not have a significant impact on these differences. This is because the p-value of the Spearman and Kendall correlations was greater than 0.1. In other words, an increase or decrease in the number of infections had no significant positive or negative impact on SP during the pandemic.

Are there significant differences between 2019 and 2020 in terms of the AGR of IC among MCs and between MCs and the top 10 countries in terms of COVID-19 infections? Are they affected by the number of COVID-19 cases?

Table 2 shows that the overall AGR of IC increased dramatically between 2019 and 2020, both among MCs (from 3.1 to 15.1%) and between MCs and the top ten epidemic countries (from 2.7 to 12.8%). As with the total SP, France, Italy, and Spain outpaced all of the MCs in both forms of IC. The USA, the United Kingdom, and Germany were the top collaborating countries, especially with Italy and France (for more details see Online Resource 1, C and 1, D). For the IC among MCs, Montenegro, Monaco, and Malta witnessed a decrease during the pandemic in the AGR of IC by approximately 85%, 73.4%, and 19.8%, respectively. However, the AGR improved in the rest of the countries and remained constant in Algeria. The highest rates were reported in Gibraltar, Libya, and Palestine, rising by 150%, 80.1%, and 69.7%, respectively. In terms of IC with the top 10 countries, the AGR dropped in seven countries, including Gibraltar (193.9%), Monaco (192.5%), Montenegro (182.9%), Bosnia and Herzegovina (24.2%), Malta (22.8%), Algeria (19%), and Syria (2.3%). Nevertheless, it increased in other MCs. Palestine, Libya, and Albania had the highest AGRs, jumping by 104.3%, 59.9%, and 45.4%, respectively, as shown in Fig. 4. The result of the Mann–Whitney test was zero for the IC among MCs; there was a significant difference between the two years. The medians of both years were 3.76% and 16.12%, proving that it progressed during 2020. Similarly, IC between MCs and the top 10 countries increased. The p-value of the test was 0.097, and there was a significant difference between the median values of the two years, 4.03% and 14.36%. The correlation tests also
The annual growth rate of scientific publishing in the Mediterranean countries before and during COVID-19

*Global rank refers to the ranking of countries in terms of COVID-19 cases globally

**The 2018 values were extracted only to calculate the AGR for 2019, but they are out of the study scope

| Regional rank | *Global rank | Continent /country | No. of cases | No. of publication ** | AGR 2019 | AGR 2020 |
|---------------|--------------|--------------------|--------------|----------------------|----------|----------|
| 1             | 5            | EU/France          | 2,576,420    | 124,196 121,049 123,754 | − 2.5    | 2.2      |
| 2             | 7            | EU/Italy           | 2,107,166    | 123,465 127,876 142,969 | 3.6      | 11.8     |
| 3             | 8            | EU/Spain           | 1,893,502    | 98,589 101,396 113,471 | 2.8      | 11.9     |
| 4             | 13           | EU/Turkey          | 1,394,314    | 45,593 49,607 56,955 | 8.8      | 14.8     |
| 5             | 31           | AF/Morocco         | 439,193      | 7,545 8,661 9,425 | 14.8     | 8.8      |
| 6             | 34           | AS/Israel          | 408,277      | 22,907 23,203 25,067 | 1.3      | 8.0      |
| 7             | 46           | EU/Croatia         | 212,007      | 7,688 7,826 7,869 | 1.8      | 0.5      |
| 8             | 52           | AS/Lebanon         | 181,503      | 3,591 3,936 4,630 | 9.6      | 17.6     |
| 9             | 58           | AS/Palestine       | 155,365      | 870 1,025 1,173 | 17.8     | 14.4     |
| 10            | 63           | AF/Tunisia         | 139,140      | 8,598 8,240 8,384 | − 4.2    | 1.7      |
| 11            | 64           | EU/Greece          | 138,850      | 20,405 20,794 22,425 | 1.9      | 7.8      |
| 12            | 65           | AF/Egypt           | 138,062      | 22,029 25,725 31,813 | 16.8     | 23.7     |
| 13            | 70           | EU/Slovenia        | 123,950      | 6,506 6,941 7,006 | 6.7      | 0.9      |
| 14            | 74           | EU/Bosnia and Herzegovina | 110,985   | 1,441 1,570 1,657 | 9.0      | 5.5      |
| 15            | 76           | AF/Libya           | 100,277      | 503 554 675 | 10.1     | 21.8     |
| 16            | 77           | AF/Algeria         | 99,610       | 7,768 8,631 7,937 | 11.1     | − 8.0    |
| 17            | 89           | EU/Albania        | 58,316       | 530 549 620 | 3.6      | 12.9     |
| 18            | 94           | EU/Montenegro      | 48,231       | 511 576 617 | 12.7     | 7.1      |
| 19            | 106          | AS/Cyprus          | 22,651       | 3023 3,287 3908 | 8.7      | 18.9     |
| 20            | 124          | EU/Malta          | 12,774       | 992 974 1,087 | − 1.8    | 11.6     |
| 21            | 127          | AS/Syria          | 11,434       | 502 576 731 | 14.7     | 26.9     |
| 22            | 170          | EU/Gibraltar      | 1,973        | 11 6 19 | − 45.5   | 216.7    |
| 23            | 179          | EU/Monaco         | 875          | 180 240 284 | 33.3     | 18.3     |
| Total         |              |                    | 10,374,875   | 507,443 523,242 572,476 | 3.1      | 9.4      |
showed that the number of infections had no impact on the differences in IC among MCs (p-value > 0.1). They did, however, confirm that IC between the MCs and the top ten epidemic countries was influenced by the number of infections (p-value < 0.1). The relationship appeared moderately positive, implying that an increase in infections enhanced the IC between MCs and the top ten countries.

Are there significant differences between 2019 and 2020 in terms of the characteristics of SP? Are they affected by the number of COVID-19 cases?

Main subject areas

As Table 3 and Fig. 5 indicate, only the life sciences witnessed a rise in publications in all 23 MCs during the first year of the COVID-19 period. The largest differences were achieved by Italy, Spain, France, Egypt, and Turkey, with 7391, 3480, 3329, 2607, and 2106 publications, respectively. The other subject areas experienced an increase in most of the MCs. For the physical sciences, the largest differences were in Spain, Turkey, and Italy, where SP increased by 2812, 2742, 1965, and 1145 publications, respectively. Additionally, Italy, Spain, France, Turkey, and Egypt had the largest increases in the health sciences, with increases of 14,124, 7928, 5803, 4981, and 2279, respectively.

According to the correlation coefficient values, there was a strong positive relation; the number of publications in these three sciences grew as the number of infections increased.

The COVID-19 topic in the main subject areas

Concerning the SP related to COVID-19, the physical, health, and life sciences remained unchanged during 2020 in two countries—Gibraltar and Monaco—although it grew in the rest of the countries. Italy, Spain, and France had the greatest positive variations, increasing by 677 in the physical sciences, 6406 in the health sciences, and 2062 in the life sciences;
### Table 2: The annual growth rate of international collaboration in the Mediterranean countries before and during COVID-19

| Regional rank | Continent/country         | No. of Cases | IC among the MCs | AGR | IC between the MCs and the top 10 epidemic countries | AGR |
|---------------|--------------------------|--------------|-----------------|-----|-----------------------------------------------------|-----|
|               |                          |              | No. of publication |     | No. of publication |     |
|               |                          |              | 2018 2019 2020    |     | 2019 2020                                              |     |
| 1             | EU/France                | 2,576,420    | 30,506 30,857 33,889 | 1.2 | 9.8                                                   | 50,621 50,637 54,597 | 0.0 | 7.8 |
| 2             | EU/Italy                 | 2,107,166    | 28,100 29,182 34,114 | 3.9 | 16.9                                                  | 46,926 48,116 55,839 | 2.5 | 16.1 |
| 3             | EU/Spain                 | 1,893,502    | 23,243 24,118 28,007 | 3.8 | 16.1                                                  | 37,175 38,335 43,450 | 3.1 | 13.3 |
| 4             | EU/Turkey                | 1,394,314    | 6,728 7,103 8,597  | 5.6 | 21.0                                                  | 8,923 9,614 11,251 | 7.7 | 17.0 |
| 5             | AF/Morocco               | 439,193      | 3,051 3,149 3,595 | 3.2 | 14.2                                                  | 1,543 1,525 1,744 | −1.2 | 14.4 |
| 6             | AS/Israel                | 408,277      | 5,711 5,628 6,500 | −1.5 | 15.5                                                  | 11,374 11,590 12,960 | 1.9 | 11.8 |
| 7             | EU/Croatia               | 212,007      | 4,206 4,315 4,601 | 2.6 | 6.6                                                   | 3,490 3,548 3,682 | 1.7 | 3.8 |
| 8             | AS/Lebanon               | 181,503      | 1,724 1,916 2,363 | 11.1 | 23.3                                                  | 1,245 1,362 1,837 | 9.4 | 34.9 |
| 9             | AS/Palestine             | 155,365      | 700 535 782     | −23.6 | 46.2                                                  | 511 340 581 | −33.5 | 70.9 |
| 10            | AF/Tunisia               | 139,140      | 3,662 3,470 3,984 | −5.2 | 14.8                                                  | 919 956 1,228 | 4.0 | 28.5 |
| 11            | EU/Greece                | 138,850      | 9,176 9,408 10,826 | 2.5 | 15.1                                                  | 10,356 10,538 11,276 | 1.8 | 7.0 |
| 12            | AF/Egypt                 | 138,062      | 3,278 3,596 4,711 | 9.7 | 31.0                                                  | 5,812 6,492 8,051 | 11.7 | 24.0 |
| 13            | EU/Slovenia              | 123,950      | 3,825 3,825 4,278 | 0.0 | 11.8                                                  | 3,027 3,029 3,267 | 0.1 | 7.9 |
| 14            | EU/Bosnia and Herzegovina| 110,985      | 756 680 827     | −10.1 | 21.6                                                  | 278 347 349 | 24.8 | 0.6 |
| 15            | AF/Libya                 | 100,277      | 288 255 430     | −11.5 | 68.6                                                  | 207 192 293 | −7.2 | 52.6 |
| 16            | AF/Algeria               | 99,610       | 3,209 3,365 3,534 | 4.9 | 5.0                                                   | 802 1,026 1,118 | 27.9 | 9.0 |
| 17            | EU/Albania               | 58,316       | 384 445 596     | 15.9 | 33.9                                                  | 143 159 249 | 11.2 | 56.6 |
| 18            | EU/Montenegro            | 48,231       | 281 681 1,070  | 142.3 | 57.1                                                  | 91 349 700 | 283.5 | 100.6 |
| 19            | AS/Cyprus                | 22,651       | 2,798 2,974 3,401 | 6.3 | 14.4                                                  | 2,268 2,235 2,467 | −1.5 | 10.4 |
| 20            | EU/Malta                 | 12,774       | 719 853 843     | 18.6 | −1.2                                                  | 498 592 569 | 18.9 | −3.9 |
| 21            | AS/Syria                 | 11,434       | 142 167 250     | 17.6 | 49.7                                                  | 128 157 189 | 22.7 | 20.4 |
| 22            | EU/Gibraltar             | 1,973        | 4 4 10          | 0.0 | 150.0                                                 | 3 11 19 | 266.7 | 72.7 |
| 23            | EU/Monaco                | 875          | 165 294 308     | 78.2 | 4.8                                                   | 107 296 249 | 176.6 | −15.9 |
| Regional rank | Continent /country | No. of Cases | IC among the MCs | IC between the MCs and the top 10 epidemic countries |
|---------------|--------------------|--------------|-----------------|--------------------------------------------------|
|               |                    |              | No. of publication | AGR | No. of publication | AGR |
|               |                    |              | 2018 2019 2020   | 2019 2020 | 2018 2019 2020   | 2019 2020 |
| Total         |                    | 10,374,875 | 132,656 136,820 157,516 | 3.1 15.1 | 186,447 191,446 215,965 | 2.7 12.8 |
in the physical sciences, 2529 in health sciences, and 703 in life sciences; and 213 in the physical sciences, 2604 in the health sciences, and 832 in the life sciences, respectively. The three leading countries also led in both the social sciences (Italy, 559; Spain, 535; and France, 246) and multidisciplinary sciences (Italy, 139; France, 84; and Spain, 62), whereas a few countries witnessed no change in the two subject areas, as shown in Table 4 and Fig. 6. The tests proved that the pandemic had a substantial impact on the SP tagged under COVID-19 (p-value < 0.1). As predicted, for all of the sciences, the infection number had a significant effect on the SP related to COVID-19 (p-value < 1). The correlation coefficients indicated a strong positive relationship; that is, the publications tagged under COVID-19 increased as the number of infections increased.

The COVID-19 topic in the most relevant medical specialties

Overall, the SP in most COVID-19-related medical specialties increased. A rise in parasitology and tropical medicine publications was absent or very rare (1 or 2 publications in 4 countries), but it was concentrated, for other specialties, in seven countries: Italy, Spain, France, Turkey, Israel, Greece, and Egypt. The largest increases in virology, infectious diseases and public, environmental and occupational health were recorded by Italy (1145, 435, and 201), while the most marked increase (588) in immunology came from Spain (see Table 7 in the Appendix and Fig. 7). Except for parasitology and tropical medicine, all the specialties analysed were affected by the emergence of the virus (p-value < 0.1). While it was thought that the number of infections would have a significant impact on all 10 core medical specialties associated with COVID-19, the tests revealed the opposite. For parasitology and tropical medicine, the number of cases was weakly correlated with SP in both disciplines (p-value > 0.1). The p-value for the others was less than 0.1, and the values of the correlation coefficients proved that these specialties were positively correlated with the case count.

Languages

English was, as predicted, the most dominant language for publishing. English publications saw a boost after COVID-19 in all MCs except Algeria, where they dropped by 468. With the exception of Spanish publications, which increased by 929 in Spain,
Table 3 Scientific publishing before and during COVID-19 in Mediterranean countries according to the main subject areas

| Regional rank | Continent/country     | No. of cases | Physical Sciences | Health Sciences | Social Sciences | Life Sciences | Multidisciplinary |
|---------------|-----------------------|--------------|-------------------|-----------------|----------------|---------------|-------------------|
|               |                       |              | 2019              | 2020            | 2019          | 2020          | 2019              | 2020            | 2019          | 2020          |
| 1             | EU/France             | 2,576,420    | 66,962            | 63,301          | 33,343        | 39,146        | 16,932            | 17,009          | 28,075        | 31,404        | 3,209         | 3,108         |
| 2             | EU/Italy              | 2,107,166    | 64,682            | 65,827          | 41,498        | 55,622        | 20,035            | 21,779          | 31,648        | 39,039        | 2,793         | 2,479         |
| 3             | EU/Spain              | 1,893,502    | 48,568            | 51,380          | 29,452        | 37,380        | 21,460            | 24,283          | 24,886        | 28,366        | 2,668         | 2,560         |
| 4             | EU/Turkey             | 1,394,314    | 24,703            | 26,668          | 17,240        | 22,221        | 7,301             | 7,948           | 9,349         | 11,455        | 468           | 596           |
| 5             | AF/Morocco            | 439,193      | 6,819             | 7,232           | 1,064         | 1,631         | 1,123             | 1,305           | 1,053         | 1,565         | 100           | 137           |
| 6             | AS/Israel             | 408,277      | 10,435            | 10,330          | 6,865         | 8,471         | 5,309             | 5,527           | 5,366         | 6,054         | 637           | 711           |
| 7             | EU/Croatia            | 212,007      | 3,591             | 3,726           | 2,203         | 2,438         | 1,955             | 2,019           | 1,636         | 1,853         | 137           | 102           |
| 8             | AS/Libanon            | 181,503      | 1,815             | 1,738           | 1,524         | 2,200         | 683               | 813             | 800           | 1,022         | 70            | 86            |
| 9             | AS/Palestine          | 155,365      | 628               | 645             | 207           | 320           | 215               | 280             | 167           | 197           | 32            | 30            |
| 10            | AF/Tunisia            | 139,140      | 5,734             | 5,632           | 1,498         | 1,745         | 999               | 1,225           | 1,546         | 1,687         | 83            | 95            |
| 11            | EU/Greece             | 138,850      | 11,374            | 11,121          | 6,741         | 8,253         | 3,410             | 3,757           | 4,656         | 5,408         | 272           | 266           |
| 12            | AF/Egypt              | 138,062      | 15,242            | 17,984          | 6,809         | 9,088         | 1,772             | 1,974           | 7,125         | 9,732         | 522           | 665           |
| 13            | EU/Slovenia           | 123,950      | 3,906             | 3,800           | 1,380         | 1,744         | 1,725             | 1,453           | 1,357         | 1,688         | 153           | 157           |
| 14            | EU/Bosnia and Herzegovina | 110,985 | 832               | 947             | 506           | 501           | 324               | 338             | 220           | 268           | 10            | 19            |
| 15            | AF/Libya              | 100,277      | 362               | 466             | 103           | 154           | 80                | 81              | 115           | 146           | 9             | 20            |
| 16            | AF/Algeria            | 99,610       | 7,554             | 6,945           | 498           | 572           | 731               | 641             | 1,121         | 1,240         | 104           | 99            |
| 17            | EU/Albania            | 58,316       | 289               | 307             | 171           | 208           | 114               | 155             | 127           | 143           | 7             | 8             |
| 18            | EU/Montenegro         | 48,231       | 303               | 389             | 151           | 123           | 154               | 141             | 147           | 153           | 4             | 6             |
| 19            | AS/Cyprus             | 22,651       | 1,696             | 1,852           | 883           | 1,141         | 927               | 1,119           | 595           | 753           | 47            | 47            |
| 20            | EU/Malta              | 12,774       | 472               | 443             | 318           | 438           | 218               | 296             | 170           | 189           | 17            | 17            |
| 21            | AS/Syria              | 11,434       | 295               | 347             | 201           | 274           | 40                | 61              | 186           | 234           | 9             | 28            |
| 22            | EU/Gibraltar         | 1,973        | 5                 | 3               | 0             | 8             | 2                 | 2               | 3             | 9             | 1             | 1             |
| 23            | EU/Monaco             | 875          | 97                | 107             | 88            | 104           | 30                | 48              | 70            | 102           | 14            | 10            |
| Total         |                       | 10,374,875   | 272,773           | 281,190         | 152,743       | 193,782       | 85,539            | 92,254          | 120,418       | 142,707       | 11,366        | 11,247        |
publications in other languages decreased in some countries and stabilized in others during 2020. Italy led publishing in English with a difference of 16,048 papers, followed by Spain (12,573), Turkey (8223), Egypt (6181), and France (2838), as depicted in Table 5 and Fig. 8. Nonetheless, the publication languages were not affected by the emergence of COVID-19 (p-value > 0.1). The p-value of the correlation tests was greater than 0.1 for Spanish, Turkish, and other languages, indicating that the number of cases did not significantly affect the SP in these languages. However, this number had a considerable influence on SP in English, French, and Italian (p-value < 0.1). According to the values of the correlation coefficients, there was a strong positive relationship for English publications, a moderate negative relationship for French publications, and a strong negative relationship for Italian publications. Consequently, the more cases of infection there were, the more publications produced in English and the fewer in French and Italian there were.

Types

Likewise, the spread of COVID-19 had no significant effect on the publication type (p-value > 0.1). Table 8 in the Appendix and Fig. 9 reveal that conference papers decreased in all the MCs except for Bosnia and Herzegovina, Libya, and Montenegro, which saw increases. Additionally, book chapters declined in all the MCs but Montenegro and Syria. Retractions and business articles presented only minor variations or remained constant in almost all the countries. On the other hand, articles, letters, and reviews increased in most countries. Publication type was partially influenced by the case count. The p-value of the tests was more than 0.1 for retractions and business articles, reflecting that publications of either type were not significantly affected by the number of cases. However, the case count had an impact on other types (p-value < 0.1). The correlation coefficients for articles, review papers, letters, editorials, notes, errata, and data papers showed a strong or moderately positive relationship. However, there was a strong or moderately negative relationship for conference papers, book chapters, short surveys, and books.
| Regional rank | Country                  | No. of cases | Physical Sciences 2019 | Physical Sciences 2020 | Health Sciences 2019 | Health Sciences 2020 | Social Sciences 2019 | Social Sciences 2020 | Life Sciences 2019 | Life Sciences 2020 | Multidisciplinary 2019 | Multidisciplinary 2020 |
|---------------|-------------------------|--------------|------------------------|------------------------|-----------------------|-----------------------|----------------------|----------------------|--------------------|----------------------|-------------------------|-------------------------|
| 1             | EU/France               | 2,576,420    | 3                      | 216                    | 14                    | 2618                  | 0                    | 246                  | 23                 | 85                   | 1                       | 85                      |
| 2             | EU/Italy                | 2,107,166    | 2                      | 679                    | 21                    | 6427                  | 1                    | 560                  | 15                 | 2077                 | 0                       | 139                     |
| 3             | EU/Spain                | 1,893,502    | 1                      | 412                    | 14                    | 2543                  | 0                    | 535                  | 11                 | 714                  | 0                       | 62                      |
| 4             | EU/Turkey               | 1,394,314    | 1                      | 137                    | 8                     | 1252                  | 0                    | 122                  | 6                  | 322                  | 0                       | 13                      |
| 5             | AF/Morocco              | 439,193      | 0                      | 60                     | 2                     | 170                   | 0                    | 28                   | 2                  | 66                   | 0                       | 7                       |
| 6             | AS/Israel               | 408,277      | 0                      | 66                     | 0                     | 536                   | 0                    | 109                  | 0                  | 177                  | 0                       | 17                      |
| 7             | EU/Croatia              | 212,007      | 0                      | 29                     | 1                     | 169                   | 0                    | 41                   | 1                  | 40                   | 0                       | 2                       |
| 8             | AS/Lebanon              | 181,503      | 0                      | 14                     | 6                     | 173                   | 0                    | 19                   | 6                  | 72                   | 0                       | 5                       |
| 9             | AS/Palestine            | 155,365      | 0                      | 7                      | 0                     | 24                    | 0                    | 7                    | 0                  | 11                   | 0                       | 3                       |
| 10            | AF/Tunisia              | 139,140      | 0                      | 28                     | 2                     | 85                    | 0                    | 15                   | 3                  | 28                   | 0                       | 2                       |
| 11            | EU/Greece               | 138,850      | 0                      | 91                     | 0                     | 552                   | 0                    | 55                   | 3                  | 237                  | 0                       | 14                      |
| 12            | AF/Egypt                | 138,062      | 1                      | 116                    | 20                    | 494                   | 0                    | 48                   | 21                 | 228                  | 2                       | 18                      |
| 13            | EU/Slovenia             | 123,950      | 0                      | 22                     | 0                     | 90                    | 0                    | 23                   | 0                  | 43                   | 0                       | 7                       |
| 14            | EU/Bosnia and Herzegovina | 110,985   | 0                      | 6                      | 0                     | 35                    | 0                    | 3                    | 0                  | 8                    | 0                       | 1                       |
| 15            | AF/Libya                | 100,277      | 0                      | 2                      | 0                     | 23                    | 0                    | 5                    | 0                  | 9                    | 0                       | 3                       |
| 16            | AF/Algeria              | 99,610       | 1                      | 14                     | 1                     | 38                    | 0                    | 6                    | 1                  | 21                   | 0                       | 1                       |
| 17            | EU/Albania              | 58,316       | 0                      | 5                      | 0                     | 15                    | 0                    | 4                    | 0                  | 6                    | 0                       | 1                       |
| 18            | EU/Montenegro           | 48,231       | 0                      | 3                      | 0                     | 6                     | 0                    | 0                    | 0                  | 5                    | 0                       | 1                       |
| 19            | AS/Cyprus               | 22,651       | 0                      | 25                     | 0                     | 68                    | 0                    | 19                   | 0                  | 26                   | 0                       | 7                       |
| 20            | EU/Malta                | 12,774       | 0                      | 4                      | 1                     | 54                    | 0                    | 12                   | 0                  | 7                    | 0                       | 1                       |
| 21            | AS/Syria                | 11,434       | 0                      | 2                      | 0                     | 16                    | 0                    | 0                    | 0                  | 7                    | 0                       | 0                       |
| 22            | EU/Gibraltar            | 1973         | 0                      | 0                      | 0                     | 0                     | 0                    | 0                    | 0                  | 0                    | 0                       | 0                       |
| 23            | EU/Monaco               | 875          | 0                      | 0                      | 0                     | 0                     | 0                    | 1                    | 0                  | 0                    | 0                       | 0                       |
| Total         |                         | 10,374,875   | 9                      | 1938                   | 90                    | 15,388                | 1                    | 1858                 | 92                 | 4959                 | 3                       | 389                     |
Considering the rankings of the journals as a measure of publication quality, it is quite impressive that Q1 and Q2 journals witnessed a rise in all the countries after COVID-19. The greatest increases were in Italy (14,102 in Q1, 7306 in Q2), Spain (8590 in Q1, 5469 in Q2), France (8036 in Q1, 2389 in Q2), Turkey (4817 in Q1, 3864 in Q2), and Egypt (3265 in Q1, 2708 in Q2). Other rankings, on the other hand, saw a drop in several countries. For the Q3 journals, the greatest differences were in Spain, Turkey, Morocco, Israel, Croatia, Lebanon, Palestine, Tunisia, Greece, and Egypt, where the publications increased by 1227, 1192, 1081, 1030, 1030, 1030, 1030, 1030, 1030, and 1030, respectively. The SP in Q4 and indexed journals decreased sharply in most of the MCs. Conversely, the greatest difference in Q4 journals, 820, was seen in Egypt, whereas Monaco’s publications in indexed journals increased by only 6 (Table 6 and Fig. 10). Nevertheless, the tests proved that COVID-19 did not significantly affect SP in any of the ranks of international journals (p-value > 0.1). The correlation tests revealed that the relationship was strong or moderately positive for Q1, Q2, and Q3 journals, whereas
### Table 5  Scientific publishing before and during COVID-19 in Mediterranean countries according to the publication language

| Regional rank | Continent/country         | No. of cases | English | French | Spanish | Italian | Turkish | Others | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   | 2019   | 2020   |
|---------------|---------------------------|--------------|---------|--------|---------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|        |
| 1             | EU/France                 | 2,576,420    | 114,723 | 117,561| 10,412  | 9758   | 310    | 277   | 92     | 49     | 3      | 5      | 337    | 263    |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 2             | EU/Italy                  | 2,107,166    | 123,872 | 139,920| 251    | 178    | 378    | 381   | 3873   | 2848   | 11     | 1      | 218    | 250    |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 3             | EU/Spain                  | 1,893,502    | 91,751  | 104,324| 229    | 203    | 13,543 | 14,472| 67     | 43     | 1      | 0      | 405    | 330    |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 4             | EU/Turkey                 | 1,394,314    | 47,517  | 55,740 | 65     | 70     | 60     | 107   | 11     | 5      | 2418   | 2113   | 42     | 46     |        |        |        |        |        |        |        |        |        |        |        |        |
| 5             | AF/Morocco                | 439,193      | 8337    | 9507   | 465    | 388    | 8      | 6     | 0      | 0      | 0      | 1      | 2      | 3      |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 6             | AS/Israel                 | 408,277      | 23,244  | 24,755 | 32     | 22     | 14     | 7     | 3      | 1      | 0      | 0      | 48     | 49     |        |        |        |        |        |        |        |        |        |        |        |        |
| 7             | EU/Croatia                | 212,007      | 6798    | 7327   | 8      | 4      | 3      | 7     | 10     | 10     | 0      | 0      | 1089   | 860    |        |        |        |        |        |        |        |        |        |        |        |
| 8             | AS/Lebanon                | 181,503      | 3914    | 4592   | 72     | 58     | 1      | 4     | 1      | 0      | 0      | 0      | 2      | 2      |        |        |        |        |        |        |        |        |        |        |
| 9             | AS/Palestine              | 155,365      | 1022    | 1241   | 1      | 1      | 1      | 1     | 0      | 0      | 0      | 0      | 2      | 6      |        |        |        |        |        |        |        |        |        |        |
| 10            | AF/Tunisia                | 139,140      | 8026    | 8390   | 401    | 319    | 4      | 6     | 2      | 1      | 0      | 0      | 1      | 2      |        |        |        |        |        |        |        |        |        |        |
| 11            | EU/Greece                 | 138,850      | 20,640  | 22,387 | 33     | 23     | 16     | 16    | 4      | 4      | 0      | 1      | 178    | 178    |        |        |        |        |        |        |        |        |        |
| 12            | AF/Egypt                  | 138,062      | 25,741  | 31,922 | 26     | 31     | 27     | 34    | 0      | 1      | 0      | 0      | 19     | 28     |        |        |        |        |        |        |        |        |        |
| 13            | EU/Slovenia               | 123,950      | 6442    | 6722   | 9      | 9      | 0      | 5     | 5      | 11     | 0      | 0      | 541    | 439    |        |        |        |        |        |        |        |        |
| 14            | EU/Bosnia and Herzegovina| 110,985      | 1539    | 1697   | 4      | 0      | 0      | 0     | 1      | 0      | 1      | 2      | 53     | 37     |        |        |        |        |        |        |        |        |
| 15            | AF/Libya                  | 100,277      | 154     | 223    | 0      | 2      | 0      | 0     | 0      | 0      | 0      | 0      | 1      | 0      |        |        |        |        |        |        |        |        |        |
| 16            | AF/Algeria                | 99,610       | 8515    | 8047   | 185    | 143    | 3      | 7     | 1      | 1      | 0      | 1      | 6      | 5      |        |        |        |        |        |        |        |        |
| 17            | EU/Albania                | 58,316       | 548     | 643    | 1      | 3      | 2      | 3     | 1      | 1      | 1      | 0      | 1      | 3      |        |        |        |        |        |        |        |        |
| 18            | EU/Montenegro             | 48,231       | 559     | 629    | 7      | 0      | 1      | 1     | 1      | 3      | 0      | 0      | 23     | 19     |        |        |        |        |        |        |        |
| 19            | AS/Cyprus                 | 22,651       | 3262    | 3913   | 5      | 5      | 3      | 2     | 0      | 1      | 33     | 11     | 23     | 26     |        |        |        |        |        |        |        |
| 20            | EU/Malta                  | 12,774       | 985     | 1134   | 0      | 0      | 1      | 2     | 0      | 0      | 0      | 0      | 3      | 1      |        |        |        |        |        |        |        |
| 21            | AS/Syria                  | 11,434       | 92      | 127    | 0      | 1      | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0      |        |        |        |        |        |        |        |
| 22            | EU/Gibraltar              | 1973         | 6       | 19     | 0      | 0      | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 0      |        |        |        |        |        |        |        |
| 23            | EU/Monaco                 | 875          | 241     | 268    | 7      | 6      | 0      | 0     | 0      | 0      | 0      | 0      | 0      | 1      |        |        |        |        |        |        |        |
| **Total**     |                           | 10,374,875   | 497,928 | 551,088| 12,213 | 11,224 | 14,375 | 15,338| 4072   | 2979   | 2468   | 2135   | 2994   | 2548   |        |        |        |        |        |        |        |        |


it was strong or moderately negative for Q4 and indexed journals. As such, increases in the case count resulted in more publications in Q1, Q2, and Q3 journals and fewer publications in Q4 and indexed journals (p-value < 0.1).

In summary, neither the number of publications nor the growth rates showed an upwards trend between 2019 and 2020 in some countries. Statistical tests also showed that some increases and decreases were not significant. According to the findings, the first year of COVID-19 witnessed significant differences in terms of the volume of SP, the two kinds of IC, the SP tagged under COVID-19, and most of the related medical specialties. There was also a positive relationship between the number of COVID-19 cases and the following: the IC between the MCs and the top ten epidemic countries, the SP in the health, social, and life sciences, SP classified under COVID-19 in all fields, most of the relevant medical specialties, publications in the English language, most types of publications (articles, review papers, letters, editorials, notes, errata, and data papers), and publishing in Q1, Q2, and Q3 journals. The case count was negatively correlated with publications in the French and Italian languages, some publication types (conference papers, book chapters, short surveys, and books), and publishing in Q4 and indexed journals.
| Regional rank | Continent/country     | No. of cases | Q1    | Q2    | Q3    | Q4    | Indexed in Scopus |
|---------------|----------------------|-------------|-------|-------|-------|-------|------------------|
|               |                      |             | 2019  | 2020  | 2019  | 2020  | 2019  | 2020  | 2019  | 2020  |
| 1             | EU/France            | 2,576,420   | 61,838| 69,874| 21,545| 23,934| 11,974| 12,495| 11,589| 9985  |
| 2             | EU/Italy             | 2,107,166   | 59,184| 73,286| 29,195| 36,501| 15,963| 16,993| 9479  | 8230  |
| 3             | EU/Spain             | 1,893,502   | 51,915| 60,505| 19,836| 25,305| 13,427| 14,654| 9149  | 8166  |
| 4             | EU/Turkey            | 1,394,314   | 14,103| 18,920| 12,867| 16,731| 10,871| 12,063| 6551  | 6520  |
| 5             | AF/Morocco           | 439,193     | 1701  | 2303  | 1841  | 2319  | 2023  | 2579  | 1461  | 1463  |
| 6             | AS/Israel            | 408,277     | 13,045| 15,117| 4928  | 5801  | 1867  | 1957  | 830   | 779   |
| 7             | EU/Croatia           | 212,007     | 2590  | 3097  | 1648  | 1936  | 1437  | 1416  | 1266  | 1018  |
| 8             | AS/Lebanon           | 181,503     | 1529  | 2090  | 957   | 1249  | 583   | 718   | 245   | 240   |
| 9             | AS/Palestine         | 155,365     | 328   | 446   | 292   | 377   | 146   | 199   | 98    | 112   |
| 10            | AF/Tunisia           | 139,140     | 2456  | 2655  | 2325  | 2701  | 1540  | 1758  | 586   | 621   |
| 11            | EU/Greece            | 138,850     | 8977  | 10,584| 4888  | 6013  | 2763  | 2833  | 1437  | 1394  |
| 12            | AF/Egypt             | 138,062     | 8505  | 11,770| 6650  | 9358  | 4951  | 6032  | 2675  | 3495  |
| 13            | EU/Slovenia          | 123,950     | 3000  | 3499  | 1552  | 1835  | 1064  | 1012  | 669   | 440   |
| 14            | EU/Bosnia and Hercegovina | 110,985 | 294  | 383  | 339  | 381  | 325  | 335  | 372  | 446  |
| 15            | AF/Libya             | 100,277     | 153   | 214   | 122   | 167   | 105   | 120   | 59    | 62    |
| 16            | AF/Algeria           | 99,610      | 1781  | 2047  | 2137  | 2467  | 1896  | 1944  | 1140  | 972   |
| 17            | EU/Albania           | 58,316      | 122   | 180   | 108   | 158   | 116   | 160   | 123   | 91    |
| 18            | EU/Montenegro        | 48,231      | 158   | 237   | 137   | 144   | 114   | 103   | 120   | 89    |
| 19            | AS/Cyprus            | 22,651      | 1395  | 1816  | 688   | 1039  | 461   | 553   | 300   | 229   |
| 20            | EU/Malta             | 12,774      | 342   | 434   | 268   | 309   | 122   | 161   | 91    | 82    |
| 21            | AS/Syria             | 11,434      | 126   | 168   | 150   | 222   | 157   | 163   | 109   | 157   |
| 22            | EU/Gibraltar         | 1973        | 5     | 9     | 1     | 4     | 0     | 5     | 0     | 1     |
| 23            | EU/Monaco            | 875         | 162   | 201   | 41    | 42    | 21    | 21    | 9     | 7     |
| Total         |                      | 10,374,875  | 233,709| 279,835| 112,515| 138,993| 71,926| 78,274| 48,358| 44,599| 56,734| 30,775|
Discussion

This study provided a scientometric interpretation of the impact of the COVID-19 crisis on SP in the Mediterranean region. It answered an essential question as to whether this pandemic has inspired academics to conduct more research to address the pandemic’s dimensions and potential consequences, or, on the contrary, has led them to fear and anxiety and reduced their productivity as they have confronted the outbreak socially, psychologically and even economically.

One of the methods used to identify the implications of COVID-19 was to calculate the AGRs of 2019 and 2020 for SP and IC and obtain the differences between the two years. Pal (2021) and Sahoo and Pandey (2020) also applied this method to measure the pandemic’s impacts. Both found tremendous growth in COVID-19 research since January 2020. This study is consistent with their findings by revealing significant growth in SP, from 3.1% to 9.4% in the MCs during the first year of COVID-19 across all disciplines, although the AGR declined in eight countries. The AGR of IC also significantly increased in most MCs, by 12% for IC among MCs and 10% for IC with the top ten epidemic countries. Although they did not achieve the highest growth rates during 2020, Italy, France, and Spain, respectively, occupied the top of the SP and IC lists and the other lists of the SP characteristics. This is consistent with the findings of the latest papers examining the features of the global COVID-19 literature, which revealed the advanced positions that these countries occupy, especially Italy, which has often been ranked third worldwide after the U.S.A. and China (da Silva et al., 2020; Ho & Liu, 2021; Pal, 2021; Usman & Ho, 2021). The following four positions were occupied in various orders by Turkey, Egypt, Israel, and Greece. Interestingly, countries that are characterized by low production and placed at the bottom of the SP list (e.g., Malta, Gibraltar, and Monaco) recorded either the highest or lowest growth rates. This suggests that these countries were the most influenced by the pandemic, either positively or negatively, i.e., the pandemic was a motivator for some of these countries and a hurdle for others. The differentials between countries in productivity, especially during the COVID-19 era, have been explained in many studies. The research contribution from nations with large economies has been higher than that from nations with small or medium-sized economies (Mukherjee, 2020). Sociologically, it is expected that COVID-19 will increase health, education, and labour disparities among citizens all over the world (Rodríguez-Bailón, 2020). Consequently, these differences may also appear in SP.

In terms of subjects, SP generally witnessed a rise at the three levels, for which differences were examined. The most distinct differences were achieved by Italy in the subject area of health sciences (14,124), health sciences tagged as COVID-19-related (6406), and virology (1145). This indicates that the serious epidemiological situation that Italy confronted during 2020 was a huge trigger for generating more publications in health sciences. However, these differences were not statistically significant for the main subject areas, whereas they were positively influential for COVID-19-tagged literature and the majority of the COVID-19-related medical specialties. The number of COVID-19 publications increased dramatically in the health sciences, followed by the life, physical, social, and interdisciplinary sciences. This finding is somewhat in line with Fernandez-Cano (2021)’s list of core subject areas, which include Science and Technology, Social Sciences, and Art and Humanities. Moreover, the most significant differences in most COVID-19-relevant medical disciplines were found in virology, immunology, and infectious diseases, which vary slightly from the rankings of Zhang et al. (2020)—virology and infectious diseases.
The reasons for the 2020 growth have been interpreted by some analyses of the COVID-19 research as follows: the virus’s spread and the losses it has caused, which have prompted researchers to race to discover its nature and address novel related topics; a shift in publishing practices, the most significant of which is the reduction in the time required for editing and review work; the encouragement of governments and funding agencies; and finally, more available time for scientists to conduct research as a result of their home isolation and the greater reliance on new forms of scientific communication, such as preprint repositories and posting of preliminary results via social media (Chung et al., 2020; da Silva, 2020; Helliwell et al., 2020; Ho & Liu, 2021; Homolak et al., 2020; Koerber, 2020; Kun, 2020; Sahoo & Pandey, 2020).

Although COVID-19 had no effect on publication languages, the study revealed the English language’s dominance in publications from the MCs. Following English, the most widely used languages were Spanish, French, and Italian, which is consistent with Al-Zaman (2021) and da Silva et al. (2020) who found that English ranked first worldwide and Spanish ranked third during the initial period of the pandemic. The statistical tests also showed that the virus had no effect on publication types in 2020. Nonetheless, there are some positive and negative differences between the two studied years that should be discussed in light of the consequences of the pandemic that affect the scientific community. In agreement with Al-Zaman (2021), Sahoo and Pandey (2020), and da Silva et al. (2020), the massive rise of articles represented this type’s unrivalled dominance. This is definitely due to articles’ wider acceptance as the principal means of disseminating knowledge, which enables more scientists to share information about this crisis (Oh & Kim, 2020). Further, the emergence of the COVID-19 topic prompted a boost in letters to editors. This is because they are easier and faster to write and edit, represent a platform for reviewing the latest results, and highlight future research prospects (Turki et al., 2018). The drop in conferences was predicted as a result of the travel ban and prohibition of events imposed by most countries during 2020 to prevent the spread of the virus. The decline in retractions, on the other hand, was surprising in light of the phenomenon of the acceleration of publishing reported by da Silva (2020); Soltani and Patini (2020), and Moradi and Abdi (2020), a potential consequence of which was an increase in both retractions and errata. This

![Fig. 10 Differences between 2019 and 2020 according to the rankings of the journals in which the Mediterranean publications were published. Each bar represents the change between 2019 and 2020 according to the number of publications in the quartile. The positive values indicate an increase in the volume, while the negative values indicate a decrease.](image-url)
phenomenon itself may also explain the increase in publications in higher-ranked journals in 2020, except in the Q4 and indexed journals in Scopes. This is despite the evidence that the pandemic had no effect on SP according to these ranks. Largely in line with Oh and Kim (2020) who studied COVID-19 publications in nursing journals, the MCs’ documents were published in Q1, Q2, Q3, Q4, and indexed journals, respectively. The first- and second-quartile journals accounted for 73% of the 2020 publications, implying the quality that characterized the literature from MCs during the first year of COVID-19.

The most notable merit of the current study is the investigation of the correlation between the number of COVID-19 cases and the volume of SP and its attributes. Sachini et al. (2021) inferred that the volume of European publications and COVID-19 cases were positively correlated. The current findings support this correlation in certain respects while denying it in others. Amazingly, the tests showed that variations in case volume have no effect on SP growth or the IC among MCs, whereas a positive relationship between this volume and the IC between MCs and the top ten countries was demonstrated. This was more evident for the IC between France, Italy, and Spain, which represent the highest-ranked MCs in terms of cases, and the United States, the United Kingdom, and Germany, which are all on the top ten list. These collaborative practices among the world’s disease hotspots have previously been demonstrated by Sachini et al. (2021), Pal (2021), Belli et al. (2020), and Zhang et al. (2020). Among MCs, Italy was the most frequently mentioned as one of those spots.

In terms of the subjects, it was rational that the number of infections correlated positively with health and life sciences and COVID-19 papers under both the main subject areas and the majority of medical specialties. Surprisingly, there was a positive relationship with the social sciences, even though it appears to be less relevant to the pandemic context. This result seems to arise from calls from some researchers to investigate this crisis from a social perspective rather than just from a health perspective, especially with regard to the economic and behavioural implications (Usman et al., 2020; Zhang & Shaw, 2020). Further, the WHO launched a research roadmap in March 2020 in light of the outbreak, which includes some knowledge gaps classified under the social sciences (World Health Organization, 2020a).

The rise in the number of cases was also positively correlated with the increase in English publications, given that English is the global language of scientific research. During such a globally unprecedented situation, researchers from epidemic countries wished to communicate with one another urgently to exchange experiences and knowledge, which is harder to accomplish through other languages. The same interpretation can be extended to articles, reviews, and letters, positively associated with the growing number of infections, which require less time to edit, review, and publish, specifically during the COVID-19 period. Furthermore, the positive relationship between the number of cases and the increase in publishing in Q1, Q2, and Q3 journals demonstrated that the greater the number of cases was, the higher the motivation to achieve more qualified and accurate research as required by higher-impact journals.

**Conclusion**

The current study makes a unique contribution by evaluating the COVID-19 impact on SP in all specialties focusing on the Mediterranean region, which was marked by diversity in the cumulative infection totals during the pandemic’s first year. This evaluation also
yielded unprecedented findings concerning the correlations between the volume and characteristics of SP and the case counts in the countries studied. Based on the results obtained, it can be said that the MCs witnessed a remarkable difference in the volume and features of SP during the COVID-19 outbreak, and this pandemic served as a powerful incentive for more international collaboration, conducting research on related topics, writing in the most common language, and using the fastest forms of communication. SP in MCs was notable not only for its expansion but also for its high-quality performance, as more publications appeared in prestigious journals. As such, this study can help academic leadership, policy-makers in higher education and research institutions, and funding agencies in those countries develop holistic visions and procedures that bridge identified research gaps and motivate researchers in all disciplines to continue generating research during this ongoing crisis.

**Limitations and future research**

To ensure optimal coverage, the Scopes database and the SciVal tool were chosen to collect the required data. However, reliance on a single database can result in biased findings; subsequent comparative analyses could also use the Web of Science to accomplish the same objectives, and the comparisons may include preprint databases. The study did not rely on citation analysis as a criterion for research quality because it was expected that, due to the study’s limited time span, the citations for this period, especially for 2020, would not reflect the real quality of the research. Rather, journal rankings were examined based on previous studies that used this benchmark (Oh & Kim, 2020) and confirmed the close relationship between these rankings and citations and that the most cited publications are usually published in journals with higher ranks (Sa’ed, 2016). Citations can be evaluated later after more time has passed. Furthermore, scientometric studies that explore the effect of a variable on scientific production usually cover two equal intervals, before and after the appearance of the variable, as in the study of (Ibrahim, 2018). In this paper, the collection of the required data started in January 2021. Therefore, the available research periods included one year before the emergence of COVID-19 (2019) and one year after it (2020). This interval can be extended to cover the following waves in future comparative work. Finally, the Mediterranean region was the sole focus of the study, and other regions could be analysed and compared.

**Appendix**

See Tables 7 and 8.
Table 7  Scientific publishing before and during COVID-19 in Mediterranean countries according to the most COVID-19-related medical specialties

| Regional rank | Continent / country  | No. of cases | Virology 2019 | Virology 2020 | Infectious Diseases 2019 | Infectious Diseases 2020 | Immunology 2019 | Immunology 2020 | Microbiology 2019 | Microbiology 2020 | Parasitology 2019 | Parasitology 2020 | Tropical Medicine 2019 | Tropical Medicine 2020 | Pharmacology & Pharmacy 2019 | Pharmacology & Pharmacy 2020 | Biochemistry & Molecular Biology 2019 | Biochemistry & Molecular Biology 2020 | Medicine, Research & Experimental Public, Environmental & Occupational Health 2019 | Medicine, Research & Experimental Public, Environmental & Occupational Health 2020 |
|---------------|----------------------|--------------|----------------|----------------|--------------------------|--------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1             | EU/France            | 2,576,420    | 13             | 503            | 5                        | 165                      | 6              | 207            | 1              | 30             | 1              | 1              | 0              | 2              | 0              | 25             | 1              | 9              | 2              | 28             | 0              | 82             |
| 2             | EU/Italy             | 2,107,166    | 14             | 1159           | 8                        | 443                      | 2              | 164            | 1              | 54             | 0              | 1              | 0              | 0              | 0              | 22             | 1              | 27             | 1              | 56             | 1              | 202            |
| 3             | EU/Spain             | 1,893,502    | 7              | 451            | 2                        | 147                      | 4              | 592            | 1              | 16             | 0              | 0              | 1              | 2              | 0              | 9              | 0              | 11             | 0              | 31             | 0              | 78             |
| 4             | EU/Turkey            | 1,394,314    | 6              | 183            | 1                        | 59                        | 0              | 60             | 1              | 7              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 9              | 0              | 11             | 0              | 31             |
| 5             | AF/Morocco           | 439,193      | 2              | 27             | 0                        | 8                        | 1              | 10             | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 1              | 0              | 0              | 0              | 3              |
| 6             | AS/Israel            | 408,277      | 0              | 96             | 0                        | 51                        | 0              | 44             | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 0              | 0              | 5              | 0              | 12             |
| 7             | EU/Croatia           | 212,007      | 1              | 13             | 0                        | 9                        | 0              | 4              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 4              | 0              | 7              |
| 8             | AS/Lebanon           | 181,503      | 4              | 23             | 1                        | 15                        | 2              | 16             | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 0              | 2              | 0              | 0              | 1              | 5              | 0              | 5              |
| 9             | AS/Palestine         | 155,365      | 0              | 6              | 0                        | 1                        | 0              | 2              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 1              | 0              | 0              | 2              |
| 10            | AF/Tunisia           | 139,140      | 3              | 11             | 2                        | 3                        | 2              | 3              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 1              | 1              | 1              | 0              | 0              | 1              |
| 11            | EU/Greece            | 138,850      | 3              | 97             | 2                        | 35                        | 0              | 56             | 0              | 2              | 0              | 0              | 0              | 0              | 0              | 2              | 0              | 5              | 0              | 8              | 0              | 18             |
| 12            | AF/Egypt             | 138,062      | 16             | 84             | 8                        | 28                        | 9              | 35             | 1              | 3              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 5              | 0              | 2              | 5              | 0              | 18             |
| 13            | EU/Slovenia          | 123,950      | 0              | 15             | 0                        | 6                        | 0              | 2              | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 1              | 0              | 1              | 0              | 5              |
| 14            | EU/Bosnia and Herzegovina | 110,985 | 0          | 2                       | 0                        | 0                      | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 1              |
| 15            | AF/Libya             | 100,277      | 0              | 6              | 0                        | 2                        | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 1              | 0              | 4              |
| 16            | AF/Algeria           | 99,610       | 0              | 4              | 0                        | 2                        | 0              | 1              | 0              | 0              | 1              | 0              | 1              | 0              | 2              | 0              | 0              | 0              | 0              | 0              | 0              | 1              |
| 17            | EU/Albania           | 58,316       | 0              | 2              | 0                        | 0                        | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 1              |
| 18            | EU/Montenegro        | 48,231       | 0              | 1              | 0                        | 0                        | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              |
| 19            | AS/Cyprus            | 22,651       | 0              | 12             | 0                        | 6                        | 0              | 5              | 0              | 1              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 0              | 2              |
| Regional rank | Continent / country | No. of cases | Virology | Infectious Diseases | Immunology | Microbiology | Parasitology | Tropical Medicine | Pharmacology & Pharmacy | Biochemistry & Molecular Biology | Medicine, Research & Experimental | Public, Environmental & Occupational Health |
|----------------|---------------------|--------------|----------|---------------------|------------|--------------|--------------|-------------------|------------------------|---------------------------------|---------------------------------|---------------------------------|
| 20             | EU/Malta            | 12,774       | 1        | 3                   | 0          | 2            | 1            | 1                 | 0                      | 0                               | 0                               | 0                               |
| 21             | AS/Syria            | 11,434       | 0        | 1                   | 1          | 0            | 0            | 0                 | 0                      | 0                               | 0                               | 0                               |
| 22             | EU/Gibraltar        | 1,973        | 0        | 0                   | 0          | 0            | 0            | 0                 | 0                      | 0                               | 0                               | 0                               |
| 23             | EU/Monaco           | 875          | 0        | 0                   | 0          | 0            | 0            | 0                 | 0                      | 0                               | 0                               | 0                               |
| Total          |                     | 10,374,875   | 70       | 2699                | 29         | 983          | 27           | 1204              | 5                      | 118                             | 1                               | 3                               | 1                               | 5                               | 0                               | 68                             | 2                               | 70                             | 7                               | 157                            | 1                               | 472                            |
| Regional rank | Continent /country       | No. of cases | Article         | Conference paper | Review       | Book chapter | Letter | Editorial |
|---------------|--------------------------|--------------|-----------------|------------------|--------------|--------------|--------|-----------|
| 1             | EU/France                | 2,576,420    | 81,948          | 91,047           | 18,901       | 11,872       | 8604   | 9795      | 3083     | 1791     | 2498     | 3284     | 2552     | 2608     |
| 2             | EU/Italy                 | 2,107,166    | 82,812          | 99,823           | 19,390       | 13,308       | 11,804  | 14,928    | 4319     | 2817     | 3263     | 5629     | 3045     | 3615     |
| 3             | EU/Spain                 | 1,893,502    | 76,567          | 89,473           | 9694         | 6687         | 7195   | 8901      | 2266     | 1274     | 1950     | 3046     | 1716     | 1874     |
| 4             | EU/Turkey                | 1,394,314    | 39,372          | 48,679           | 5539         | 3522         | 1566   | 2093      | 1219     | 717      | 1041     | 1548     | 331      | 376      |
| 5             | AF/Morocco               | 439,193      | 5390            | 6864             | 2606         | 1995         | 202    | 331       | 243      | 162      | 61       | 134      | 56       | 51       |
| 6             | AS/Israel                | 408,277      | 16,613          | 19,416           | 2981         | 2021         | 1517   | 1707      | 798      | 383      | 355      | 434      | 335      | 367      |
| 7             | EU/Croatia               | 212,007      | 5707            | 6182             | 1002         | 800          | 637    | 708       | 188      | 72       | 86       | 148      | 95       | 100      |
| 8             | AS/Lebanon               | 181,503      | 2680            | 3337             | 691          | 391          | 291    | 542       | 83       | 52       | 63       | 100      | 43       | 77       |
| 9             | AS/Palestine             | 155,365      | 771             | 1010             | 169          | 92           | 38     | 76        | 15       | 10       | 3        | 6        | 9        | 6        |
| 10            | AF/Tunisia               | 139,140      | 5897            | 6624             | 1679         | 1274         | 212    | 259       | 173      | 72       | 118      | 98       | 45       | 33       |
| 11            | EU/Greece                | 138,850      | 13,214          | 15,243           | 3588         | 2582         | 1846   | 2356      | 662      | 461      | 455      | 751      | 525      | 603      |
| 12            | AF/Egypt                 | 138,062      | 20,477          | 27,643           | 3161         | 1840         | 942    | 1419      | 544      | 223      | 175      | 308      | 103      | 132      |
| 13            | EU/Slovenia              | 123,950      | 5108            | 5742             | 832          | 420          | 519    | 544       | 240      | 113      | 37       | 84       | 84       | 94       |
| 14            | EU/Bosnia and Herzegovina| 110,985      | 1026            | 1109             | 274          | 333          | 62     | 85        | 182      | 135      | 7        | 21       | 9        | 14       |
| 15            | AF/Libya                 | 100,277      | 371             | 465              | 139          | 165          | 20     | 40        | 16       | 12       | 3        | 16       | 4        | 1        |
| 16            | AF/Algeria               | 99,610       | 5990            | 6729             | 2133         | 984          | 140    | 172       | 274      | 159      | 16       | 18       | 23       | 19       |
| 17            | EU/Albania               | 58,316       | 361             | 495              | 106          | 52           | 37     | 36        | 35       | 29       | 4        | 7        | 3        | 11       |
| 18            | EU/Montenegro            | 48,231       | 450             | 497              | 63           | 68           | 32     | 27        | 17       | 21       | 8        | 6        | 4        | 6        |
| 19            | AS/Cyprus                | 22,651       | 2239            | 2854             | 577          | 445          | 204    | 340       | 92       | 63       | 44       | 61       | 78       | 86       |
| 20            | EU/Malta                 | 12,774       | 564             | 733              | 198          | 157          | 70     | 104       | 63       | 32       | 12       | 25       | 42       | 26       |
| 21            | AS/Syria                 | 11,434       | 469             | 632              | 47           | 38           | 35     | 42        | 8        | 11       | 9        | 11       | 0        | 0        |
| 22            | EU/Gibraltar             | 1973         | 6               | 12               | 0            | 0            | 0      | 0         | 0        | 0        | 1        | 0        | 0        | 0        |
| 23            | EU/Monaco                | 875          | 181             | 200              | 9            | 4            | 23     | 40        | 3        | 1        | 10       | 9        | 3        | 4        |
| Total         |                          | 10,374,875   | 3,682,13        | 4,348,09        | 73,779       | 49,050       | 35,998 | 44,545    | 14,523   | 8610     | 10,218   | 15,745   | 9105    | 10,103   |
Table 8 (continued)

| Regional rank | Continent /country       | No. of cases | Note | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
|---------------|-------------------------|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1             | EU/France               | 2,576,420    |      | 1265 | 1406 | 815  | 1021 | 1119 | 976  | 177  | 57   | 92   | 160  | 7    | 2    |
| 2             | EU/Italy                | 2,107,166    |      | 1704 | 2197 | 824  | 1061 | 290  | 237  | 246  | 102  | 134  | 182  | 4    | 4    |
| 3             | EU/Spain                | 1,893,502    |      | 982  | 1203 | 568  | 830  | 236  | 201  | 104  | 32   | 69   | 124  | 4    | 4    |
| 4             | EU/Turkey               | 1,394,314    |      | 279  | 398  | 148  | 242  | 27   | 23   | 58   | 21   | 10   | 29   | 6    | 6    |
| 5             | AF/Morocco              | 439,193      |      | 50   | 78   | 25   | 50   | 4    | 14   | 9    | 4    | 13   | 23   | 1    | 1    |
| 6             | AS/Israel               | 408,277      |      | 312  | 347  | 171  | 224  | 65   | 37   | 104  | 26   | 16   | 8    | 1    | 0    |
| 7             | EU/Croatia              | 212,007      |      | 69   | 87   | 34   | 36   | 18   | 14   | 8    | 6    | 2    | 10   | 1    | 0    |
| 8             | AS/Lebanon              | 181,503      |      | 36   | 75   | 22   | 31   | 9    | 10   | 2    | 6    | 8    | 3    | 0    | 0    |
| 9             | AS/Palestine            | 155,365      |      | 8    | 9    | 1    | 8    | 0    | 1    | 2    | 1    | 0    | 0    | 0    | 0    |
| 10            | AF/Tunisia              | 139,140      |      | 46   | 61   | 33   | 52   | 12   | 13   | 5    | 0    | 6    | 4    | 3    | 1    |
| 11            | EU/Greece               | 138,850      |      | 268  | 362  | 127  | 150  | 30   | 36   | 45   | 17   | 21   | 28   | 0    | 1    |
| 12            | AF/Egypt                | 138,062      |      | 83   | 127  | 157  | 223  | 6    | 12   | 23   | 12   | 17   | 15   | 6    | 5    |
| 13            | EU/Slovenia             | 123,950      |      | 46   | 47   | 38   | 58   | 18   | 3    | 9    | 3    | 11   | 12   | 2    | 0    |
| 14            | EU/Bosnia and Herzegovina | 110,985 |      | 4    | 9    | 3    | 8    | 0    | 1    | 2    | 0    | 0    | 0    | 1    | 0    |
| 15            | AF/Libya                | 100,277      |      | 2    | 4    | 0    | 7    | 0    | 0    | 0    | 0    | 0    | 2    | 0    | 0    |
| 16            | AF/Algeria              | 99,610       |      | 14   | 11   | 20   | 46   | 2    | 7    | 4    | 0    | 4    | 11   | 0    | 0    |
| 17            | EU/Albania              | 58,316       |      | 1    | 0    | 0    | 5    | 0    | 0    | 3    | 0    | 0    | 0    | 0    | 0    |
| 18            | EU/Montenegro           | 48,231       |      | 2    | 1    | 0    | 4    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 19            | AS/Cyprus               | 22,651       |      | 30   | 41   | 14   | 25   | 1    | 5    | 5    | 6    | 2    | 6    | 0    | 0    |
| 20            | EU/Malta                | 12,774       |      | 10   | 20   | 6    | 11   | 4    | 2    | 2    | 2    | 1    | 2    | 0    | 0    |
| 21            | AS/Syria                | 11,434       |      | 3    | 1    | 4    | 7    | 0    | 2    | 0    | 0    | 0    | 2    | 0    | 0    |
| 22            | EU/Gibraltar           | 1973         |      | 0    | 6    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 23            | EU/Monaco              | 875          |      | 4    | 9    | 4    | 6    | 2    | 2    | 1    | 0    | 0    | 0    | 0    | 0    |
| Regional rank | Continent /country | No. of cases | Note | Erratum | Short survey | Book | Data paper | Retracted | Business article |
|---------------|--------------------|--------------|------|---------|--------------|------|------------|-----------|------------------|
|               |                    | 2019 2020    | 2019 2020 | 2019 2020 | 2019 2020 | 2019 2020 | 2019 2020 | 2019 2020 | 2019 2020 |
| Total         |                    | 10,374,875   | 5218 6499 | 3020 4105 | 1844 1595 | 809 295 | 407 621 | 35 25 | 1 1 |
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Declarations

Conflicts of interest  The author has no conflicts of interest to declare that are relevant to the content of this article.

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