COVID-19 and scientific research interests and findings in epidemiology and social sciences: a systematic review

Bruno Enagnon Lokonon[1], **Marcel Gbaguidi Alia**[1], **Romain Glèlè Kakaï**[1*]

[1]Laboratoire de Biomathématiques et d'Estimations Forestières, Université d'Abomey-Calavi, Bénin

*Corresponding Author: romain.glelekakai@fsa.uac.bj

Abstract

The emergence of COVID-19 has prompted an unprecedented scientific publication with the aim of better understanding this new disease. This study assessed the scientific impact and disciplinary priorities of the published papers on the pandemic by comparing epidemiological (EP) and social sciences (SS) research interests. Papers were identified via keywords searching using Google Scholar and Scopus databases. From an initial 1720 papers, we identified 597 relevant articles, of which 347 were for EP researches and 250 for SS studies. We extracted information, such as authors' countries, and research thematic related to EP and SS. The results revealed that most papers were authored by Asian (37.5%), European (30.5%) and American (19.6%) scientists. Only 10.1% and 2.3% of authors were affiliated with African and Oceanian institutions, respectively, indicating that the regions most affected by the pandemic mainly contributed to the scientific publications. In total, 26 research themes were recorded from both EP and SS studies. There was a high significant difference among themes in both research fields ($\chi^2 = 1204.3$, df $= 1$, p-value < 0.001). EP papers mostly dealt with clinical trials (54.5%) and diagnosis (53.3%). These papers assessed the incidence and epidemiological characteristics of the disease (incubation period, symptomatic period, recovering or death), testing tests developed, drugs and vaccines used. SS papers were mainly concerned with the sociocultural analyses (78%) and economic impact (55.6%) of the pandemic. They mainly focused on behavioral changes induced by the pandemic and strategies developed to mitigate its impacts. This study highlights the difference between regions and gaps between scientific disciplines concerning the proposed responses to control the pandemic. It is important to promote collaborative and interdisciplinary studies for health emergencies.

Keywords: SARS-Cov-2, geographical regions, research interests and findings, collaborative research

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1 Introduction

The novel coronavirus (SARS-Cov-2) causes COVID-19, a severe and acute respiratory syndrome discovered in Wuhan, China (Velavan and Meyer, 2020; Wu and McGoogan, 2020). By 1st March 2021, about 113,467,303 total confirmed cases and 2,520,550 deaths recorded worldwide (WHO, 2021) can be considered as proof of the ravages caused by the disease. On 11 March 2020, the World Health Organization (WHO) declared COVID-19 as a pandemic (i.e. a public health emergency of international concern), thereby underlining its global significance (WHO, 2020). This measure gave rise to numerous recommendations and guidelines on prevention and management from WHO itself and other predominantly vulnerable countries (Phua et al., 2020).

To control the pandemic, Non-Pharmaceutical Interventions (NPI), such as travel or movement restrictions, social-distancing, wearing masks and regular hand washing with water and soap have been promoted (Gilmore et al., 2020; Ngonghala et al., 2020; Kaslow et al., 2020). Meanwhile, scientists have been actively engaged in several research works to understand the dynamic of the pandemic (Cao et al., 2020; Gnanvi et al., 2020; Tovissodé et al., 2020). A number of research works focused on the use of mathematical models (Taboe et al., 2020; Anastassopoulou et al., 2020; Ngonghala et al., 2020). In this category, several models have been developed to predict the course of the disease (Golinski and Spencer, 2020; Agosto and Giudici, 2020; Kosmidis and Macheras, 2020). These research works have a fundamental role in guiding public health authorities to better manage the pandemic. There were also studies related to the analysis of conditions in which vaccines and other drugs can quickly lead to a community herd immunity to curtail the pandemic (Iboi et al., 2020; Gumel et al., 2021). However, research works in social sciences (SS) have less been highlighted in the search for solutions against the pandemic (Leslie et al., 2020; Van Bavel et al., 2020). Epidemiological (EP) models and clinical treatments do not always take into account the socio-cultural behaviors of the populations facing a pandemic (Abramowitz et al., 2018). In addition, social scientists are not always able to translate their knowledge on social behaviors into epidemiologically relevant insights (Abramowitz et al., 2018). Beyond bio-medical and EP issues, the COVID-19 crisis has also social and cultural impacts (UNESCO, 2020). Decision support tools to understand and guide behavior during this crisis should also go through the social sciences. An analysis of the

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adaptability of society to the pandemic, a critical assessment of the solutions proposed by the political authorities, and relations between governments and populations during the pandemic are contributions that SS can provide (Leslie et al., 2020).

The research questions addressed in this study were: (1) What has been the relative productivity in scientific publications related to COVID-19 in EP and SS? (2) what are the range of thematic topics addressed by the published EP and SS papers regarding COVID-19? and (3) do the themes prioritized in both research fields converge or diverge? The objectives of the study were to (1) assess the involvement of the scientific communities in research on COVID-19 in the field of EP and SS, (2) analyze the research themes addressed by the authors in EP and SS regarding the pandemic, and (3) summarize the main findings from the selected papers in both research fields.

2 Methods

2.1 Search strategy and papers selection

This study was conducted following the Systematic Reviews and Metanalyses (PRISMA) guidelines (Casals et al., 2014) (Figure 1). The search consisted of identifying all original published articles on COVID-19 using Google Scholar and Scopus databases. To find the papers, we used the following keywords: “COVID-19”, “coronavirus”, “SARS-CoV-2”, “2019-nCoV”, “n-CoV”, and “Pandemic”. The following fields were included separately in the search in combination with the keywords: “Epidemiology” and “social sciences”. The search was restricted to published articles between 1 January 2020 and 31 December 2020.

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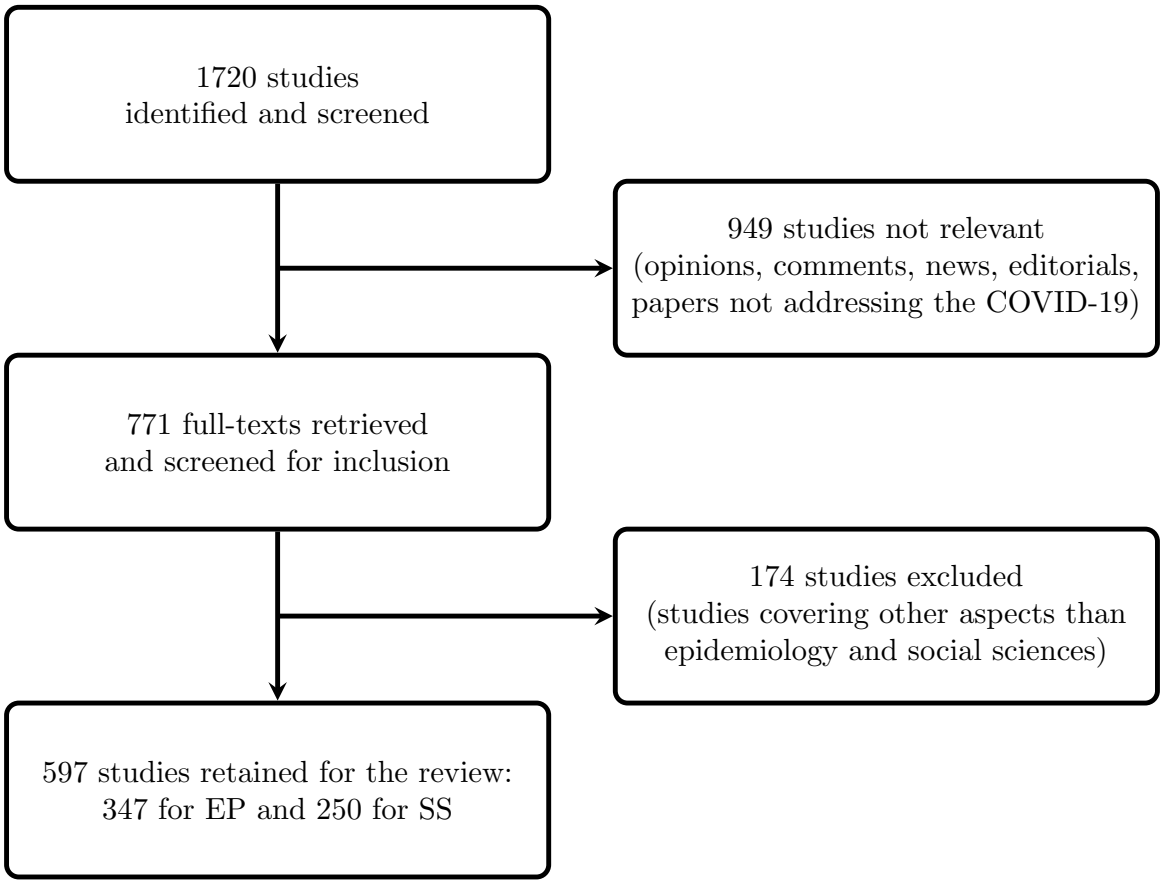

Figure 1: PRISMA flow diagram.

Two levels of screening were used. At the first level, abstracts were reviewed for the exclusion criteria. Indeed, abstracts without full-texts, proceedings, letters or commentaries, news reports and news reviews were excluded. Full-text versions were obtained for all articles accepted at this level. At the second level, distinct inclusion and exclusion criteria were applied to the 2 research fields (epidemiology and social sciences). For EP studies, papers selected included a primary collection or use of data related to COVID-19. Concerning the SS, selected articles reported SS themes linked to the coronavirus disease.

From a list of 1720 papers, 597 were finally retained with 347 from EP and 250 for SS studies (see Supplementary Material for the full list).

2.2 Data extraction and analysis

Data extraction was performed separately by two people following the approach used by Abramowitz et al. (2018). The two separate analyses were then merged and disagreements

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between the themes and sub-themes were reconciled. From each included papers, the following data were extracted: geographical location (country and continent) of authors, funded or unfunded status of the study and source of funding. To analyze the range of research topics addressed by the EP and SS published articles, themes and subthemes were extracted from a review of full-text articles. Each theme was coded as a binary variable (0 = No, 1 = Yes) when a related subtheme was mentioned or not in the full-text.

Count and relative frequencies were computed and barplots were used to describe provenance of the authors, funded or unfunded status of the study and source of funding. Moreover, proportions of themes were calculated for EP and SS and a comparison test of two proportions was performed to assess the difference between the two research fields. The analyses were conducted using R software, version 4.0.2 (R Core Team, 2020). The main findings from the selected papers were summarized and future research directions were provided.

3 Results

3.1 Characteristics of the selected papers: geographical distribution, collaboration and funding

Most papers were authored by Asian (37.5%), European (30.5%) and American (19.6%) researchers (Figure 2). Only 10.1% and 2.3% of authors were respectively affiliated with African and Oceanian institutions. In addition, most of the research studies were carried out in one geographical region (79.3%), whereas only 20.7% were from collaborations between geographical regions (continents).

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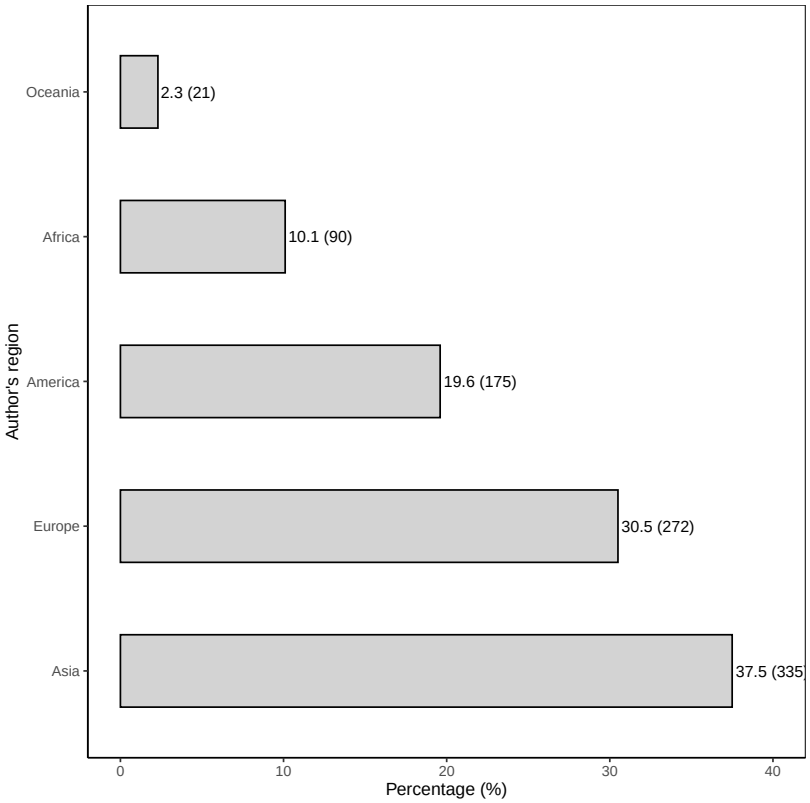

Figure 2: Distribution of authors per region.

Table 1 presents per country, the relative productivity in scientific publications related to COVID-19 in EP and SS for the most represented countries. Most of the papers came from China (15.9%), United States (12.1%) and Italy (7.6%).

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Table 1: Distribution of papers per country.

Country	%(n)	Country	%(n)
China	15.9 (142)	Greece	2.1 (19)
USA	12.1 (108)	Saudi Arabia	2.1 (19)
Italy	7.6 (68)	Nigeria	1.9 (17)
South Korea	5.0 (45)	Israel	1.8 (16)
Canada	4.8 (43)	South Africa	1.7 (15)
UK	4.8 (43)	Iran	1.7 (15)
India	4.1 (37)	Malaysia	1.7 (15)
Spain	2.8 (25)	Poland	1.6 (14)
France	2.8 (25)	Tanzania	1.6 (14)
Germany	2.7 (24)	Switzerland	1.5 (13)
Brazil	2.7 (24)	Egypt	1.3 (12)
Singapore	2.7 (24)	Cameroon	1.2 (11)
Russia	2.6 (23)	Kenya	1.2 (11)
Japan	2.5 (22)	Benin	0.9 (8)
Australia	2.4 (21)	Sierra Leone	0.2 (2)
Belgium	2.0 (18)		

The majority of the selected papers (66.8%) were not financially supported (28.8% gave no information about funding and 38.0% stated that they did not receive any funding) (Figure 3). In total, 13.4% of the selected papers were funded by European, 12.4% by Asian, 6.4% by American and 0.5% by African and Oceanian institutions, respectively. Moreover, it is noted that, European funding mainly supported European authors (82.7%) and Asian funding mainly supported Asian authors (78.5%).

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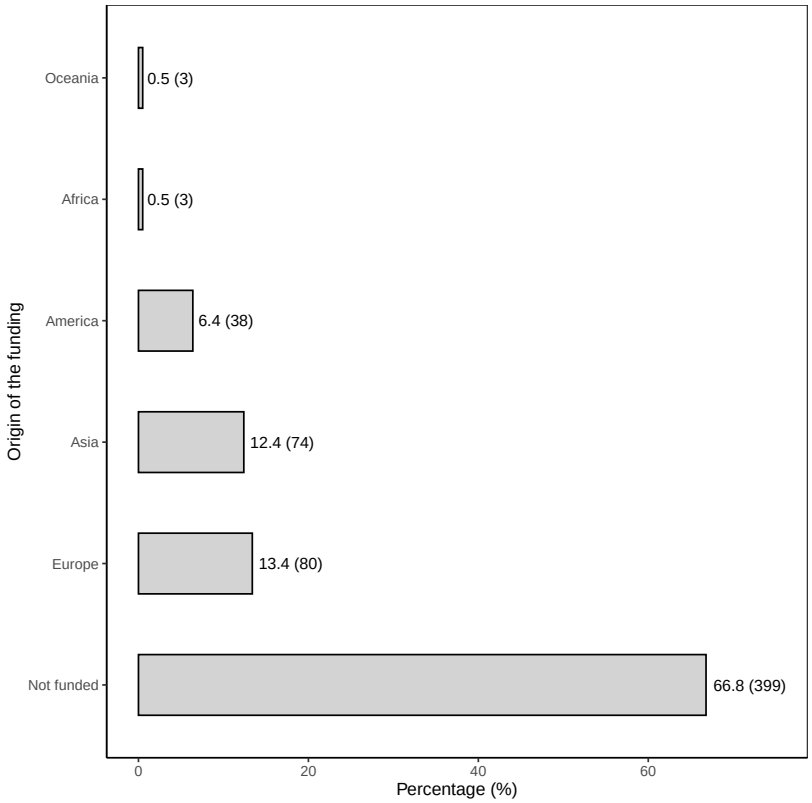

Figure 3: Breakdown of funding granted to research works on COVID-19.

3.2 Relative importance of themes considered

A total of 26 themes were identified with 350 subthemes. Table 2 presents the number (n) and percentage (%) of papers per themes for EP and SS, respectively.

EP papers prioritized studies related clinical trials (54.5%), diagnosis of COVID-19 (53.3%) and other EP themes including incidence, mortality and characterizing outbreaks (37.4%). These proportions were significantly higher (Prob < 0.05) than those for SS (Table 2). SS papers prioritized Sociocultural themes (78%) and the economic impact of the pandemic (55.6%). Other themes related to prevention and response to the pandemic were considered. These themes were: ethics (53.1%), funerary practices and burials (53.1%) and political issues (51.8%). All these proportions were significantly higher (Prob < 0.05) than those for EP papers (Table 2). Finally, the two research fields showed similar priority (Prob > 0.05) for the themes related to clinical characteristics, health systems, comparison of COVID-19 with past disease outbreaks and modelling (Table 2).

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Table 2: Themes and proportions of papers for EP and SS.

Themes	**EP [%(n)]**	**SS [%(n)]**	**Prob**
Age groups/vulnerable populations	13.2 (46)	23.2 (58)	0.002
Alternative health practices	1.5 (5)	46.9 (117)	< 0.001
Clinical characteristics	40.9 (142)	34.4 (86)	0.125
Clinical trials	54.5 (189)	42.4 (86)	0.005
Community engagement	19.4 (67)	45.6 (114)	< 0.001
Diagnosis	53.3 (185)	9.5 (24)	< 0.001
Economic impact	7.8 (27)	55.6 (139)	< 0.001
Epidemiology themes	37.4 (130)	22.8 (57)	0.005
Ethics	10.5 (36)	53.1 (133)	< 0.001
Funerals/burials	1.5 (5)	53.1 (133)	< 0.001
Health communications strategies	6.9 (24)	39.4 (99)	< 0.001
Health systems	25.7 (89)	39.4 (99)	0.060
Mobility	10.5 (36)	50.6 (127)	< 0.001
Modelling	33.4 (116)	27.2 (68)	0.124
Other diseases addressed/compared	32 (111)	40.6 (102)	0.235
Political themes	5.1 (18)	51.8 (130)	< 0.001
Risk factors	14 (49)	38.1 (96)	< 0.001
Psychosocial	7.8 (27)	49.3 (124)	< 0.001
Public health response	8.7 (30)	43.1 (108)	< 0.001
Post-Covid	6 (21)	43.1 (108)	< 0.001
Rumors, myths and misinformation	0.6 (2)	9.5 (24)	0.004
Sociocultural themes	26.6 (92)	78 (195)	0.002
Sensitivity-specificity	6 (21)	44.4 (111)	< 0.001
Transportation	6 (21)	40.6 (102)	< 0.001
Survivors reintegration	9.6 (33)	38.1 (96)	< 0.001
Transmission	18.5 (64)	41.9 (105)	0.001

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3.3 Summary of main findings on COVID-19

Key results obtained from the reviewed papers are presented below.

Diagnosis

To detect COVID-19, several tests have been developed according to the reviewed papers. Nucleic acid amplification tests such as real-time RT-PCR are the most widely used and recommended test to confirm infection with SARS-CoV-2 (Wang et al., 2020). Rapid diagnostic tests detecting viral proteins with the potential to speed up and simplify the detection of active SARS-CoV-2 infection are also used (Zhang et al., 2020). Studies have shown that in most cases, SARS-CoV-2 becomes detectable in the upper respiratory tract around 1 to 3 days before the symptoms onset and for several days or weeks after the symptomatic period (To et al., 2020). The average time between exposure to SARS-CoV-2 and symptoms onset (the incubation period) is 5 to 6 days, but can vary from 1 to 14 days and it is estimated that in 17% to 25% of cases, the virus may be detectable without developing symptoms (Kronbichler et al., 2020).

Clinical trials

Several papers have presented results from clinical trials assessing the efficacy of drugs. The effect of drugs on 3 important outcomes in COVID-19 patients (mortality, need for assisted ventilation and duration of hospital stay) were assessed in most studies (Barnabas et al., 2020). In the cases of remdesivir, hydroxychloroquine, lopinavir/ritonavir and interferon, little or no reduction in the mortality, need for assisted ventilation and duration of hospital stay were observed (Barnabas et al., 2020). However, Spinner et al. (2020) stated that patients randomized to a 5-day course of remdesivir had a statistically significant difference in clinical status compared with the standard care, but the difference was of uncertain clinical importance. Moreover, there are many official vaccine projects subjected to clinical trials (Polack et al., 2020). The first authorized and recommended vaccines to prevent COVID-19 are Pfizer-BioNTech Moderna's COVID-19 vaccines (Anderson et al., 2020; Polack et al., 2020). According to the reviewed papers, both vaccines have shown approximately 95% efficacy in preventing symptomatic COVID-19 infections in phase 3 trials, without significant safety concerns that might

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hinder authorization (Polack et al., 2020).

Age groups/vulnerable populations

Several studies found a significant impact of age on the clinical characteristics and outcomes of COVID-19 patients (Zhao et al., 2020; Zhou et al., 2020; Verity et al., 2020; Zhang et al., 2020). The symptoms of the aged patients were more atypical than those of the young patients and were characterized by more comorbidities (Zhao et al., 2020). Moreover, older patients had more severe inflammation on admission and during hospitalization, they received oxygen therapy and experienced more complications with a significantly higher mortality rate (Verity et al., 2020; Zhang et al., 2020; Zhao et al., 2020). However, more recent studies showed higher rates of severe forms of COVID-19 in younger populations due to the mutations of the virus (Garvin et al., 2020).

Modelling

Modelling techniques have been profusely used in the scientific papers as a tool to assess the COVID-19 disease transmission dynamics and to predict its future course. The most used models were compartmental and statistical models (Tovissodé et al., 2020; Anastassopoulou et al., 2020; Agosto and Giudici, 2020; Taboe et al., 2020). The compartmental model divided the population into different sub-populations, such as Susceptible, Exposed, Infected, Quarantined, Recovered, and Dead (Ngonghala et al., 2020). Classical and improved versions of the compartmental models have been considered in many studies (Cao et al., 2020; Ngonghala et al., 2020; Taboe et al., 2020). Statistical models included growth models, spatial models, time series models, Poisson models and their alternatives (Agosto and Giudici, 2020; Tovissodé et al., 2020). Another class of models widely used are machine learning models (Gupta et al., 2020; Farooq and Bazaz, 2020). These models have contributed among others to (i) assess the impact of control interventions; (ii) generate short and long-term forecasts; (ii) determine epidemic peak time and size, epidemic size and duration (Agosto and Giudici, 2020; Tovissodé et al., 2020).

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Social and cultural analyses

Findings of several studies revealed that communities responded to the pandemic in various ways (Sutin et al., 2020; Croll et al., 2020; Dong et al., 2020; Lesser and Nienhuis, 2020). Sociocultural factors, such as behaviors, beliefs and practices, affect the responses of the communities (Duan et al., 2020; Jeffrey, 2020). For instance, while in some countries control and preventive measures, such as lockdown, closure of non-essential establishments and businesses were successfully respected, in other countries these measures were not or partially accepted (Doogan et al., 2020). Other papers have shown several negative psychological effects of social isolation of COVID-19 patients, such as high levels of anxiety, stress, or even the presence of depressive symptoms that can persist after the pandemic (Antunes et al., 2020; Duan et al., 2020). Antunes et al. (2020) found that women presented higher levels of state anxiety and trait anxiety when compared to men. An age-related variation was also found, among the youngest (18-34 years) groups showing higher levels of trait anxiety (Antunes et al., 2020).

Economics and political issues

COVID-19 has not only caused a health crisis but also a general slowdown in economic activities, especially for small and medium-sized enterprises (Kim et al., 2020; Song et al., 2020; Xie et al., 2020). It has serious impacts on trade, as well as on public and international policies (Bruns et al., 2020; Miller, 2020; Motta Zanin et al., 2020). The management of the pandemic has given rise to many doubts about the ability of leaders and administrative systems to manage the crisis (Cohen et al., 2020; Shatri et al., 2020). Some countries have undertaken measures to support workers who lost their jobs during the pandemic and to offer help to vulnerable people (Bruns et al., 2020; Meisner et al., 2020; Blustein and Guarino, 2020; Carroll et al., 2020). In addition, policy makers have not only been faced with the arduous task of finding viable solutions to respond effectively to the health crisis but also to the economic emergency to support vulnerable businesses and maintain financial stability (Cohen et al., 2020; Jeffrey, 2020; Li et al., 2020; Miller, 2020). However, despite its negative impacts on economy, the pandemic is also seen as an opportunity in some studies. Indeed, the current pandemic situation can increase the development of newer technologies (Okyere et al., 2020). These innovations may contribute to efficient ways and means of productions and low-cost productions (Karunathilake, 2020).

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Following the onset of the pandemic, several countries faced serious ethical challenges (Jeffrey, 2020). These include, but are not limited to: resources allocation, rights and duties of workers (Jeffrey, 2020; Miller, 2020; Cohen et al., 2020; Carroll et al., 2020; Ogden, 2020; Shatri et al., 2020; Sorokowski et al., 2020). These challenges were complicated by a health system and a socio-economic and cultural context of each country (Dong et al., 2020; Lesser and Nienhuis, 2020).

3.4 COVID-19 Research Perspectives

Although efforts are being made by the scientific communities worldwide to understand and fight against COVID-19, many unknowns remain regarding this pandemic. Some research subjects raised in the reviewed papers that must be addressed in future studies are presented below.

- Use of Artificial Intelligence (AI) techniques to understand COVID-19 dynamic. AI methods have been moderately used in the battle against COVID-19. AI can help to address many issues posed by COVID-19. For instance, mathematical foundations of AI can be used for real-time spread tracking, early warning and alerts for particular geographical locations and to provide accurate forecasting.
- Modelling optimal vaccine allocation strategies within and between countries to maximize health under constraints on dose supply.
- Modelling the public health impact of the COVID-19 vaccines.
- Assessing social, psychological, and economical impacts of COVID-19 on low-income countries.
- Assessing positive effects of COVID-19 on the environment and natural ecosystems.
- Incorporation of social behavior during the COVID-19 pandemic into mathematical models.
- Modelling the impact of environmental factors on the spread of COVID-19 according to the main climatic zones of the world.
- Assessing the impacts of COVID-19 on small and medium-sized businesses in Africa.
- Assessing the determinants of COVID-19 vaccines acceptance in African countries.

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4 Discussion

4.1 Scientific response to the COVID-19 pandemic

In response to the COVID-19 pandemic, scientific research is emerging at an unprecedented rate. Between 1 January and 30 April 2020, more than 4,000 publications on COVID-19 were reported on PubMed, with an average of about 33 publications everyday (Sarkis et al., 2020). It would have taken 24 months to reach the same number of articles during the 2009 H1N1 Influenza pandemic (Sarkis et al., 2020). Between 1 January and 30 November 2020, more than 38,000 Web of Science and 78,000 PubMed articles on COVID-19 were identified (Shapira, 2020). Behind this abundant scientific publication, our results revealed disparities between regions. There is a correlation between the regions and countries most affected by the pandemic and the scientific contribution. The regions with the highest number of publications and authors were Asia, Europe, and America while Africa and Oceania had lower published scientific papers. The same trend was observed for research funding and regional collaborations. These differences between regions may have several explanations. First, the most affected countries are also the richest in the world. Consequently, authorities and research funding institutions quickly understood the issues and provided research institutions with funds. Thus, the differences may be due to the influence of rapidly available added COVID-19 research funding (Shapira, 2020). Second, COVID-19 has also changed the traditional way of working. A new way of working has been clearly observed thanks to the increased use of new technologies, which requires expertise (IAU, 2020). Third, in some regions, there are not enough resources and equipment to conduct some kinds of studies as they were not enough prepared for this unexpected situation (Abramowitz et al., 2018). Moreover, due to the border closure for several months, researchers who should have traveled to conduct their research in equipped laboratories have been blocked. This prevented several experiments which should be performed.

These results call for strengthening regional collaboration. COVID-19 is completely a new situation, which invites reconsidering the existing forms of collaborations between regions. The lessons learned from previous epidemics, like Ebola or Influenza can guide. In addition, the creation of new research networks between different regions can promote exchanges of knowledge and also pooling resources and providing financial support. By funding infrastructure and research projects in the poorest regions like Africa, researchers can gain more autonomy. Skills

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will be gained and long-term collaborations between regions and sub-regions can be effective. This will help smooth out the knowledge differences between regions in order to be better prepared for future pandemics.

4.2 Epidemiological and social sciences research findings

Our research showed that the two investigated disciplines (EP and SS) have approached the pandemic in different ways and on different themes. While EP addressed themes related to clinical trials, diagnosis, incidence, mortality and outbreaks, SS prioritized sociocultural themes and economic impacts. Abramowitz et al. (2018) obtained similar results from their study on Ebola. They pointed out that the approaches used by epidemiological, social and behavioral sciences often seemed diametrically opposed. They found that epidemiology is often based on population data (eg, age, sex) to make general inferences without incorporating local insights (eg, cultural practices, traditional structures) while behavioral sciences used small samples to make sweeping inferences (Abramowitz et al., 2018).

There is a need to combine the two disciplines for more effective responses to COVID-19 or other future pandemics (Moon et al., 2015). Efforts must be made to develop new approaches for interdisciplinary research. Data collection systems integrating both EP and SS variables need to be developed. Where as much of the literature in the epidemic space situates social scientists as cultural brokers (Leslie et al., 2020), this study shows that no area of research should be overlooked when faced with a pandemic, like COVID-19. Knowledge and experiences of specialists from other fields, such as economy and finance, environment or politics need to be integrated through interdisciplinary cooperation and setting up of collaborative projects.

5 Conclusion

This study highlights the disparities between regions of the world when dealing with a health emergency, such as COVID-19. It also underlines the gaps between scientific disciplines concerning the proposed responses to control the pandemic. Based on these results, creation of international cooperation and collaboration networks between national research centres of infectious diseases is required for an efficient and global response to pandemics. The objectives of these networks will be to prepare sub-regional and national research centres to equip themselves

in resources and skills to effectively respond to present and future pandemics. We also suggest the establishment of new interdisciplinary and integrated research mechanisms and strategies in the sub-regional and national research centres. All experts who can bring relevant local contextual, medical, epidemiological, environmental and political information on global health emergencies must be involved.

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