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Tracing the Origin and Early Progression of COVID-19 in Europe: An Epidemiological Descriptive Study

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Authors
Ilyes Zatla, *PhD*[1*]
Lamia Boublenza, *PhD*[1]
Amina Boublenza, *PhD*[2]

[1] Laboratory of Microbiology applied to the Food industry, Biomedical and the Environment, Faculty of Natural and Life Sciences, Earth and Universe Sciences. Department of Biology. University of Tlemcen, Algeria.
[2] Biomedical Engineering Laboratory, Faculty of Technology, University of Tlemcen, Algeria.

*** *Correspondence***
Laboratory of Microbiology applied to the Food industry, Biomedical and the Environment, Faculty of Natural and Life Sciences, Earth and Universe Sciences. Department of Biology. University of Tlemcen, Algeria.
Email: ilyes.zatla@univ-tlemcen.dz

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ABSTRACT

Background: The ongoing global health crisis caused by the infectious coronavirus disease, known as COVID-19, is attributed to the SARS-CoV-2 virus. The pandemic has significantly impacted people of all ages and nationalities and has spread across all continents, with an initial focus on Asia and subsequently reaching Europe. The objective of this study was to analyze the progression of COVID-19 in Europe in contrast to other continents around the world by examining the pandemic's trajectory across different geographic areas, allowing us to gain insights into the effectiveness of containment measures, and identifying potential patterns of virus spread.
Materials & Methods: The data source was a curated dataset provided by Our World in Data (OWD), regularly updated during the COVID-19 pandemic. The dataset consisted of 207,316 records with 67 attributes, covering 244 locations, including countries from six continents. These attributes encompassed a wide range of COVID-19-related metrics, such as cases, deaths, testing, vaccinations, and demographic indicators. This comprehensive comparative study specifically focused on the European continent data from January 01, 2020, to August 08, 2022.
Findings. The analysis revealed distinct groups of European countries with different experiences with the virus. First, some countries were found to be severely affected by the virus, grappling with higher case numbers and mortality rates. On the other hand, some countries were able to successfully manage the virus spread. Additionally, there was a group with significant case numbers but relatively lower mortality rates. Finally, certain countries effectively limited the virus transmission while maintaining low mortality rates.
Conclusion: As the pandemic continues, it is essential to emphasize the significance of international data to develop comprehensive strategies against severe health crises. Evaluating different outcomes across continents and within specific regions could provide crucial insights to guide future control measures. However, the fight against COVID-19 is far from over, necessitating ongoing research and cooperation on a global scale.

Keywords: COVID-19, SARS-CoV-2, Infections, Mortality, Europe

CITATION LINKS

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Introduction

The ongoing COVID-19 (coronavirus disease-2019) pandemic represents the most severe health crisis associated with an acute and highly contagious virus of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [1]. COVID-19 is a progressive infectious disease with diverse transmission routes, specifically through human respiratory droplets and aerosols [2, 3]. This pandemic represents one of the most significant health emergencies associated with acute and highly transmissible diseases in the 21st century [4]. Despite global efforts to contain the virus, including the design of a preparedness and response framework for prevention, detection, containment, and treatment [5], infection and mortality rates have shown considerable variation across countries, age groups, and ethnicities [6]. Notably, several countries such as the United States of America (USA), United Kingdom (UK), Italy, Spain, France, Germany, Turkey, Iran, and Russia emerged as the global epicenters of the outbreak [7, 8]. However, it originated in Guangdong, China before international expansion [9, 10].

The pandemic has struck all continents, with Asia serving as the initial focus at the beginning of 2020, followed by a shift in focus to Europe. This study aimed to compare the progression of COVID-19 in Europe with other continents by investigating its timeline and categorizing countries based on total case numbers and mortality rates. Additionally, various factors influencing these two crucial parameters were also addressed. Such a comparative analysis contributes to a better understanding of the pandemic impact in different regions and provides valuable insights for effective management strategies.

Objectives: This research aimed to assess the advancement of COVID-19 in Europe compared to other continents globally. This involved examining the pandemic's course across diverse geographic regions, enabling us to glean insights into the efficacy of containment measures and identify potential trends in the spread of the virus.

Materials and Methods

Data source: The dataset utilized in this study was curated and maintained by OWD (Our World in Data). It was updated daily throughout the duration of the COVID-19 pandemic and drew information from various reliable sources as well as official sources and reports (Table 1) [11- 16].

Data type: The dataset comprised a total of 207,316 records, encompassing 67 attributes. The data were pertained to 244 different locations, primarily countries spanning six continents: Asia, Europe, Africa, North America, South America, and Oceania. Additionally, some locations represented aggregates of existing countries, such as Europe and the European Union.

The attributes predominantly consisted of real data types, with four exceptions: OSI code, continent, location (all character strings), and date.

List of attributes: The attributes included "iso code," "continent," "location," "date," "total cases," "new cases," "new cases smoothed," "total deaths," "new deaths," "new deaths smoothed," "total cases per million," "new cases per million," "new cases smoothed per million," "total deaths per million," "new deaths per million," "new deaths smoothed per million," "reproduction rate," "ICU (intensive care unit) patients," "ICU patients per million," "hospitalized patients," "hospitalized patients per million," "weekly ICU admissions," "weekly ICU admissions per million," "weekly hospital admissions," "weekly hospital admissions per million," "total tests," "new tests," "total tests per thousand," "new tests per thousand," "new tests smoothed," "new

Table 1) Sources of COVID-19 data for the European continent (January 01, 2020-August 08, 2022)

Metrics	Source [11-16]	Updated	Countries
Vaccinations	Official data collated by the Our World in Data team	Daily	218
Hospital & ICU	Official data collated by the Our World in Data team	Daily	47
Tests & positivity	Official data collated by the Our World in Data team	Daily	193
Confirmed cases	JHU CSSE COVID-19 Dataz	Daily	219
Confirmed deaths	JHU CSSE COVID-19 Data	Daily	219
Reproduction rate	Arroyo-Marioli F, Bullano F, Kucinskas S, Rondón-Moreno C	Daily	195
Policy responses	Oxford COVID-19 Government Response Tracker	Daily	187
Other variables of interest	International organizations (UN, World Bank, OECD, IHME…)	Fixed	241

tests smoothed per thousand," "positive rate," "tests per case," "tests units," "total vaccinations," "people vaccinated," "people fully vaccinated," "total boosters," "new vaccinations," "new vaccinations smoothed," "total vaccinations per hundred," "people vaccinated per hundred," "people fully vaccinated per hundred," "total boosters per hundred," "new vaccinations smoothed per million," "new vaccinated
smoothed per million," "new vaccinated people smoothed," "new vaccinated people smoothed per hundred," "stringency index," "population," "population density," "median age," "aged older than 65 years," "aged older than 70 years," "GDP (gross domestic product) per capita," "extreme poverty," "cardiovascular death rate," "diabetes prevalence," "female smokers," "male smokers," "handwashing facilities," "hospital beds per thousand," "life expectancy," "human development index," "excess mortality cumulative absolute," "excess mortality cumulative," "excess mortality," and "excess mortality cumulative per million".

Data selection: This study specifically focused on data related to the European continent from January 01, 2020 to August 08, 2022. However, it is important to note that some data points were missing, particularly daily case numbers for countries such as Vatican, Jersey, and Guernsey. Due to these missing values, these three countries were excluded from the analysis.

Findings

COVID-19 worldwide: Since the onset of the pandemic, COVID-19 has impacted 585,408,156 cases worldwide, with a devastating death toll of 6,420,207 people. Notably, January 19, 2022

marked the day when the highest number of positive cases was reported globally, reaching a record of 4,079,467 new COVID-19 cases. Tragically, the deadliest day due to COVID-19 was January 20, 2021, witnessing 2,139,507 deaths in a single day.

Global spread of COVID-19: Asia was the first continent affected by the pandemic, and subsequently, the virus spread to all continents (Figure 1), albeit with substantial disparities among them. Overall, Europe reported 219,407,121 confirmed cases and 1,889,765 confirmed deaths. In North America, there were 109,491,859 cases and 1,482,132 deaths. Asia recorded 169,915,694 cases and 1,457,051 deaths. South America reported 62,615,478 cases and 1,318,190 deaths. Africa reported 12,282,287 cases and 256,176 deaths, while Oceania saw 11,694,996 cases and 16,878 deaths.

During the initial wave in April 2020 (Figure 2), the death-to-positive case ratio was higher, likely due to limited testing capacity at the beginning of the pandemic. The European continent emerged as the most affected continent, followed by North America.

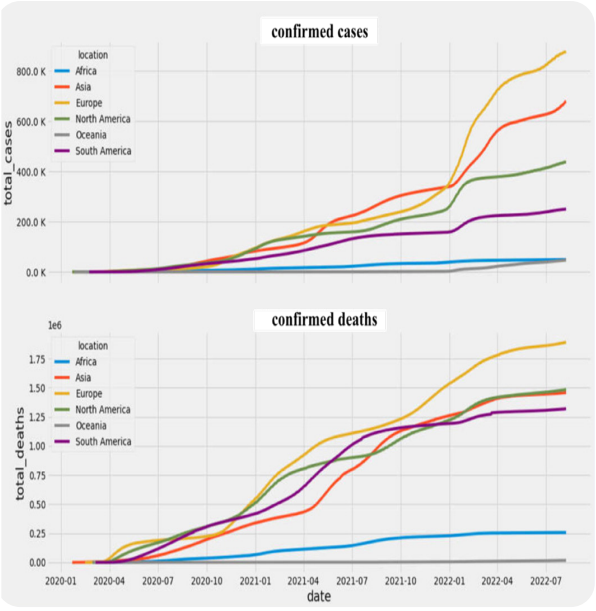

Figure 1) Worldwide evolution of COVID-19 cases and deaths (January 2020 - August 2022)

South America experienced a similar deadly first wave but with a three-month delay in onset. Oceania and Africa were the least affected continents by the initial wave.

Timeline of COVID-19 in Europe

Analysis of new cases: France reported the first COVID-19 cases in Europe on January 24, 2020, followed by Germany and Finland on January 27 and 29 of the same year, respectively. The last European countries affected were the Isle of Man on March 20, 2020, Lithuania on March 19, and Montenegro on March 17.

On March 31, 2022, Germany recorded the highest number of new cases in a single day, with a total of 527,487 cases. France, on the other hand, had the highest average number

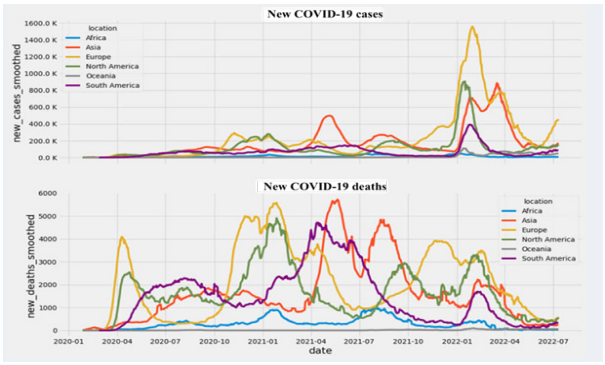

Figure 2) Timeline of COVID-19 spread and waves worldwide (January 2020-August 2022)

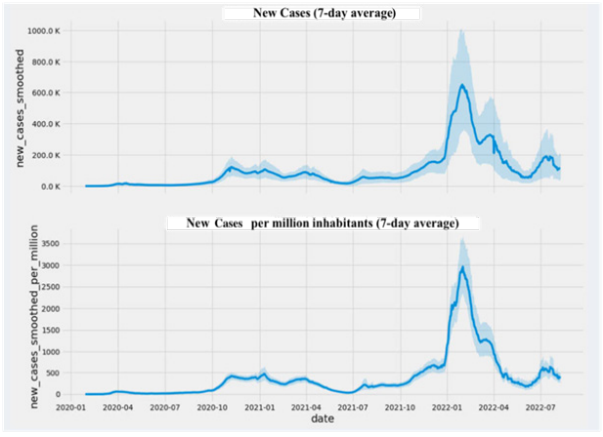

Figure 3) Evolution of new COVID-19 cases in Europe (January 2020-August 2022)

of new cases per week, with an average of 366,554 new cases in the week leading up to January 25, 2022.

The countries least affected by COVID-19 in terms of population were Belarus, Albania, and Bosnia and Herzegovina, while the Faroe Islands, Cyprus, and Gibraltar were among the most affected countries.

Analysis of new confirmed deaths: France recorded the first COVID-19 deaths in Europe on February 15, 2020, followed by Italy and San Marino on February 21 and 29, respectively. The last European countries reporting confirmed COVID-19 deaths were the Faroe Islands on January 6, 2021, Gibraltar on November 11, 2020, and Malta on April 8, 2020.

On January 20, 2021, the United Kingdom reported the highest number of deaths in a single day, with a total of 1,820 confirmed deaths. The United Kingdom also had the highest average number of deaths per week, with an average of 1,249 new deaths in the week leading up to January 23, 2021.

Countries classification: The countries were classified based on two parameters: the total number of confirmed cases per million inhabitants and the total number of deaths per million inhabitants by August 08, 2022, resulting in four distinct clusters.

Cluster 1 (red) included ten countries: Croatia, Czechia, Gibraltar, Greece, Latvia, Lithuania, Montenegro, San Marino, Slovakia, and Slovenia.

Cluster 2 (orange) comprised 22 countries: Andorra, Austria, Belgium, Cyprus, Denmark, Estonia, Faeroe Islands, France, Germany, Iceland, Ireland, Isle of Man, Italy, Liechtenstein, Luxembourg, Monaco, Netherlands, Portugal, Serbia, Spain, Switzerland, and the United Kingdom.

Cluster 3 (green) included seven countries: Albania, Belarus, Finland, Kosovo, Malta, Norway, and Sweden.

Cluster 4 (grey) consisted of nine countries: Bosnia and Herzegovina, Bulgaria, Hungary, Moldova, North Macedonia, Poland,Romania, Russia, and Ukraine.

Principal component analysis: To understand the relationship between different attributes, principal component analysis (PCA) was conducted for the selected attributes, such as "total number of cases per million," "total number of deaths per million," "population," "median age," "GDP per capita," "cardiovascular mortality rate," "prevalence of diabetes," "smoking rate," and "percentage of vaccine doses administered", based on their respective clusters. Due to missing vaccine dose data, a new data source was utilized.

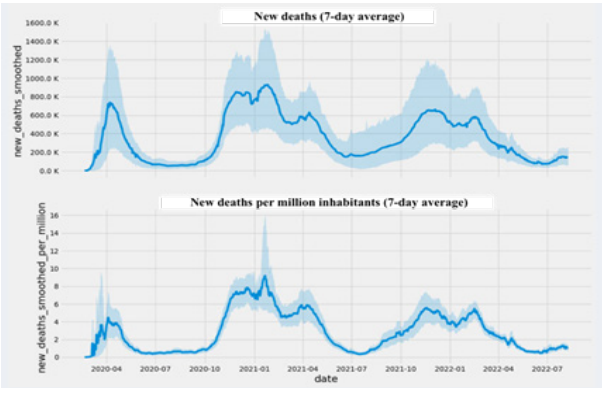

Figure 4) Evolution of new COVID-19 deaths in Europe (January 2020-August 2022)

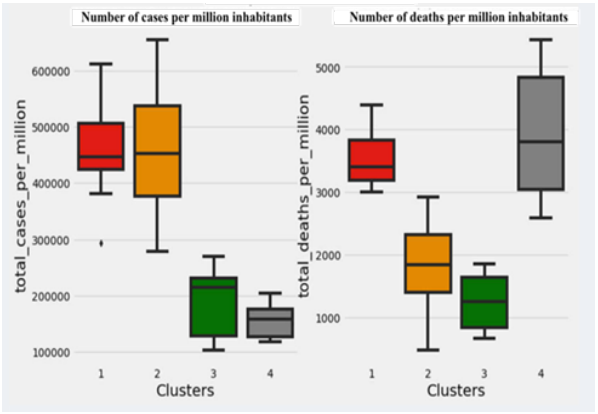

Figure 5) Boxplot of countries classification Based on COVID-19 cases and deaths (August 08, 2022)

Correlation between attributes: The number of deaths per million showed a positive correlation with the rate of smoking (p= .59), the mortality rate from cardiovascular diseases (p= .48), and the median age (p= .3). In contrast, there was an inverse correlation between the number of deaths per million and GDP per capita (p= - .53) and the percentage of administered vaccine doses (p= - .33).

Discussion

Efforts worldwide are intensifying to combat the far-reaching impact of COVID-19 [17]. Since the onset of the pandemic, the virus has inflicted 585,408,156 cases globally, resulting in a devastating death toll of 6,420,207 people. January 19, 2022 marked a significant milestone, witnessing the highest number of positive cases recorded in a single day (4,079,467 cases). Tragically, the deadliest day due to COVID-19 occurred on January 20, 2021, with 2,139,507 deaths recorded in a single day.

The first continent impacted by the pandemic was Asia, and it subsequently spread to all continents, albeit with notable disparities among them. In Europe, confirmed cases reached 219,407,121, resulting in 1,889,765 confirmed deaths. North America reported 109,491,859 cases and 1,482,132 deaths. Asia recorded 169,915,694 cases and 1,457,051 deaths. South America saw 62,615,478 cases and 1,318,190 deaths, while Africa reported 12,282,287 cases and 256,176 deaths. Oceania recorded 11,694,996 cases and 16,878 deaths.

The first COVID-19 deaths in Europe were documented in France on February 15, 2020, followed by Italy and San Marino on February 21 and 29 of the same year, respectively. The latest European countries reporting confirmed COVID-19 deaths were the Faroe Islands on January 6, 2021, Gibraltar on November 11, 2020, and Malta on April 8, 2020.

Among European countries, Spain, France, Germany, and the United Kingdom experienced the highest number of cases and deaths (after Italy). Spain was particularly impacted with restricted air traffic and military interference in regulating local and regional movements [18]. The United Kingdom had the highest number of deaths in a single day, with 1,820 confirmed deaths reported on January 20, 2021. Furthermore, during the week ending January 23, 2021, the United Kingdom recorded an average of 1,249 new deaths, making it the week with the highest average number of deaths.

Our findings revealed strong correlations between different clusters and specific variables. Cluster 3, representing countries with high case numbers but low mortality rates, showed a strong correlation between the percentage of administered vaccine doses and the number of cases per million. Cluster 1, characterized by high total numbers of cases and deaths, was positively correlated with smoking rate and, unsurprisingly, with mortality rate. Cluster 2, representing countries with low case numbers but high total mortality rates, was positively correlated with cardiovascular diseases but inversely correlated with GDP per capita. Cluster 4, representing countries least affected by COVID-19 in terms of cases and deaths, exhibited an inverse correlation with median age.

While vaccines offer a ray of hope for the future, the challenges posed by COVID-19 are far from over. The pandemic repercussions on the economic, cultural, and public health domains have been immense, and societies may require a considerable amount of time to fully recover. Although the increasing availability of vaccines brings relief, comprehensive strategies and public support are vital to prevent further devastating outbreaks in the future. Low

vaccine uptake and reduced adherence to non-pharmaceutical interventions (NPIs) hinder the path out of the pandemic, and the emergence of new variants of concern (VOCs) could potentially reduce the effectiveness of current vaccines [19]. Addressing these challenges requires continued global cooperation and vigilance in the face of evolving health crises.

While the findings provide valuable insights, the study has some limitations. The dataset, although extensive, may not capture all nuances and variations among countries. Additionally, due to the rapidly evolving nature of the pandemic, data up to the study cut-off date might not reflect the latest developments. Moreover, the study focused primarily on case numbers and mortality rates, but other relevant factors, such as healthcare capacity, socio-economic disparities, and public policy responses, could further enrich our understanding.

Future research could explore the impact of vaccination campaigns, the effectiveness of various public health interventions, and the long-term consequences of the pandemic on different aspects of society. Additionally, regional analyses and cross-country comparisons may offer deeper insights into factors influencing COVID-19 outcomes.

Conclusion

COVID-19 has left no country unaffected, but its impact has varied across regions. This study shed light on the global impact of COVID-19 and the diverse responses of countries, with a particular focus on the European continent. The identification of four distinct groups based on case numbers and mortality rates highlights the complexity of the pandemic trajectory. The first group comprised countries severely devastated by the virus, experiencing both high case numbers and substantial death tolls. The second group was able to manage the virus transmission to some extent, but their healthcare systems faced challenges in handling the surge in cases, resulting in increased mortality rates. Conversely, the third group faced a high number of cases, but the mortality rate remained relatively lower. Finally, the last group of countries successfully controlled the virus spread while maintaining a low death rate.

Looking ahead, the coming years remain uncertain as to whether we will be able to fully overcome the pandemic or face new challenges in the form of destructive waves. To increase the likelihood of positive outcomes, it is crucial to build on the lessons learned from the first phases of the pandemic. Promoting equitable vaccine distribution, bolstering healthcare infrastructure, and continued adherence to effective preventive measures will be vital in overcoming this ongoing health crisis. As we move forward, a collaborative, data-driven approach is essential to addressing the pandemic complexities. By drawing from the collective knowledge of global health experts, policymakers, and communities, we could better prepare for any potential future challenges and foster a more resilient world in the face of pandemics.

List of Abbreviations

GDP: Gross domestic product
Hosp: Hospital
ICU: Intensive care unit
IHME: Institute for Health Metrics and Evaluation
PCA: Principal component analysis
JHU CSSE: Johns Hopkins University Coronavirus Center for Systems Science and Engineering
NPI: Non-pharmaceutical intervention
OECD: Organization for Economic Cooperation and Development
OSI: Open system interconnection
OWD: Our World in Data

UN: United Nations
VOC: Variant of concern

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