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COVID-19 Monthly Pandemic Evolution in Algeria

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Abstract
Our study's objective was to retrospectively evaluate the pandemic Coronavirus Infection Disease first appeared in 2019 (COVID-19) in Algeria from July 2020 until February 2022 by studying the evolution and relationship between three variables: the number of new cases, the number of new deaths, and the number of cases hospitalized in intensive care. Data were obtained from "Our world in Data Organisation" (https://ourworldindata.org/coronavirus) on 01 March 2022. They were proceeded by descriptive and multivariate analysis. The correlation between the three variables and the analysis of individual principal components (PCA) were conducted. The number of new cases shot up the month of January 2022 with 33685 cases, the peak number of cases in intensive care was recorded in July 2021 with 1261 cases whereas the number of new deaths reached its peak in the month of August 2021 with 1015 cases. A significant linear dependence has been identified between the number of new cases and the number of cases in intensive care (R^2>0.5). The PCA analysis allowed us to distinguish the months of August 2020, November 2020, July 2021, August 2021, September 2021, and January 2022. They were characterized by high levels of new confirmed cases, new deaths and/or cases in intensive care. During the study period, the pandemic COVID-19 in Algeria passed by three waves characterized by peaks in the number of new cases and new deaths.

Keywords: Principal Components Analysis (PCA); Correlation; COVID-19 pandemic; New cases; New deaths; Intensive care

Introduction

Viral infections such as Corona virus are one of the most dangerous and challenging diseases to treat [1]. The virus was discovered in the 1930s when the American researchers Schalk and Hawn reported a new acute respiratory disease in the chicks characterized by respiratory distress. The virus was called Infections Bronchitis Virus (IBV) [2]. It was not considered as a pathogen agent responsible for human diseases until the 1960s when the first case appeared and was reported as a cold; around 500 patients were identified as having the flu-like syndrome. The Coronavirus was treated as a simple non-lethal virus until 2002 [3].

The 21th century has known three deadly pandemic caused by Corona virus [1]. Between November 2002 and July 2003 an infectious agent caused an atypical pneumonia epidemic in the province of Guangdong, the South of China. It was characterized by high fever and mild symptoms but quickly evolved in to pneumonia in a few days. The infectious agent responsible for severe acute respiratory syndrome (SARS) was called SARS-CoV; it infected 8437 individuals and killed 813 victims in the world, thus representing the first pandemic well documented [4]. The second pandemic was the Middle East respiratory syndrome Coronavirus (MERS-CoV). From April 2012 to December 2019, 2,499 laboratory-confirmed cases of MERS-Cov with 858 deaths were reported from 27 countries to the World Health Organisation (WHO). The majority of cases were reported by Saudi Arabia (2106 cases and 780 deaths) [5]. The third pandemic was caused by SARS-CoV-2, the pathogenic agent of COVID-19 [1].

Coronavirus Disease appeared in Wuhan in China, at the end of December 2019 and spread quickly in a few weeks to other regions of the country. Two weeks later, cases of COVID-19 were detected in many countries, which led to a global health crisis [6]. The 11th March 2020 the world health organization (WHO) stated that the actual Corona virus disease was a pandemic [7] where 118,000 cases were reported in 114 countries and more than 90 per cent of those cases are clustered in just four countries: China, Italy, South Korea and Iran. The 27 February 2022, over 433 million confirmed cases and over 5.9 million deaths were recorded by the WHO [8].

Algeria is part of the world countries where the confirmed COVID-19 cases reached more than 225484 cases with more than 6404 deaths in 15 January 2022 [9]. The virus started spreading on 25 February 2020 when an Italian citizen from Lombardy, one of the most affected regions in Italia, arrived at the airport of Ouargla province and tested positive to SARS- COV-2. From there, a family living in Blida province was infected, spreading the virus throughout the country [6].

Statistical analysis plays an essential role for decision-makers to decide which countermeasures are appropriate for each pandemic stage. Three areas where statistical analysis are vital could be listed: epidemiological surveillance, description of epidemiological parameters and development of mathematical models [10]. Among the statistical models of the pandemic COVI-19 we cite characterization of the disease [11,12], prediction of the disease spread [13] and evaluation of new treatments and vaccines [14]. The availability and quality of data as well as the contradictory statements of scientists led however to confused results and opened a serious debate on the results validity [15].

Quite a few statistical works on the pandemic COVID-19 in Algeria were published. The available data concerns mainly the mathematical modeling studies, predicting the spread of the pandemic [16-19] and measurement of epidemiological factors of the pandemic [20]. Despite the statistical published Algerian studies, little of works describe the evolution of the pandemic in term of relation between the number of confirmed cases, the number of deaths and the number of cases in intensive care. The characteristics of patients in intensive care and death patients was also poorly studied [21]

The objective of this study was to realize a retrospective statistical study of the monthly evolution of the pandemic COVID-19 in Algeria during a period extending from 17 July 2020 until 28 February 2022 by studying three variables: the number of new confirmed cases, the number of new deaths and the number of cases in the intensive care.

Material and Method

Data Acquisition

Data regarding the COVID-19 monthly records were retrieved from "Our world in Data Organisation" (https://ourworldindata.org/coronavirus) in 01 March 2022. The site collects data from different organisations and built 207 country profiles to enable statistical studies for each country [22]. It explores the global situation of the pandemic Covid-19 where data are daily and automatically updated.

Variables

Three variables were taken into consideration: the number of new confirmed cases, the number of new deaths, and the number of cases hospitalized in intensive care. The three variables were chosen depending on the availability of data. Although the pandemic in Algeria started on 25 February 2020, there was missing data on the number of hospitalized cases in intensive care between the 25 February and the 17 July 2020. Therefore, our statistical study was conducted between the 17 July 2022 and 28

February 2022. The three variables were constructed by calculating the cumulative of daily cases per month.

Statistical Analysis

Case fatality ratio (CFR) was calculated by the following formula [23]:

CFR% = (Number of deaths/ Number of confirmed cases)×100

The relation between the three-monthly variables (N-CAS), (N-DEC) and (S-INT) was determined by calculating the Pearson correlation coefficient.

Principal component analysis (PCA) is one of the statistical methods employed for analyzing relationships between variables in a system, if all the relevant variables are known, and it can be used for dimensionality-reduction and to obtain influencing factors. PCA proceeds by projecting the original variables into a new basis lower intrinsic dimensionality called the principal components, having a linear combination of the original dataset obtained with the maximum variance. The principal results of the PCA analysis are: (i) the eigenvalues and eigenvectors *(*total variance explained by PCA factorial analysis)*,* (ii) the principal component analysis results for variables *(*component loadings, variables contributions, and communalities), (iii) the principal component analysis results for cases, i.e., cases contributions and communalities [24-26] (Tables 1 and 2).

Table 1. Eigenvalues and total variance explained by PCA factorial analysis.

Component	Eigenvalue (λ_i)	% of variance	Cumulative (%)
PC1	**2.4015**	**80.0496**	**80.0496**
PC2	**0.3974**	**13.2478**	**93.2974**
PC3	0.2011	6.7026	100.0000

Only the first two eigenvalues (**reported in bold)** were retained which corresponds to two factors; PC1 and PC2.

Table 2. Principal component analysis.

Variables	Component loadings		Variables contributions		Communalities		Σ
	PC1	PC2	PC1	PC2	PC1	PC2	
N-CAS	**-0.917**	0.238	0.350	0.142	0.841	0.898	0.898
N-DEC	**-0.849**	-0.527	0.300	0.699	0.722	0.999	0.999
S-INT	**-0.915**	0.250	0.348	0.158	0.838	0.900	0.900

Component loadings > 0.70 are indicated in bold.

Pearson correlation coefficient and PCA were conducted using the software Statistica 8: Multivariate Exploratory Techniques, Analysis of Principal components (ACP) (StatSoft Tibco Software 25).

Results

Evolution of COVID-19 Pandemic in Algeria from 17 July 2020 to 28 February 2022

Descriptive analysis of COVID-19 monthly evolution in Algeria is represented in Table 3. During the period of the study we recorded three peaks of confirmed cases: November 2020, July 2021 and January 2022. An important diminution in the number of new cases was recorded in March 2021. The number of cases in intensive care reached its peaks the months of August 2020, November 2021, July 2021and January 2022 whereas the lowest number was recorded the month of March 2021. The number of new deaths (N-DEC) achieved its peak in August 2021 and its minimum in March 2021(Figure 1).

The case of fatality rate (CFR) varied between 1.66 and 3.7. The maximum CFR value was recorded during the month of September 2021 (7.46) whereas the lowest one was recorded in January 2022 (0.9)

Table 3. Descriptive analysis of COVID-19 monthly data in Algeria

Statistics	N-CAS	N-DEC	S-INT
Mean	10973.450	266.750	797.950
Standard deviation	9317.068	221.633	291.608
Minimum	1798.000	54.000	249.000
Maximum	33685.000	1015.000	1261.000
Coefficient of variation	0.849	0.830	0.365

N-CAS: number of new cases; N-DEC: number of new deaths; S-INT: number of cases in intensive care

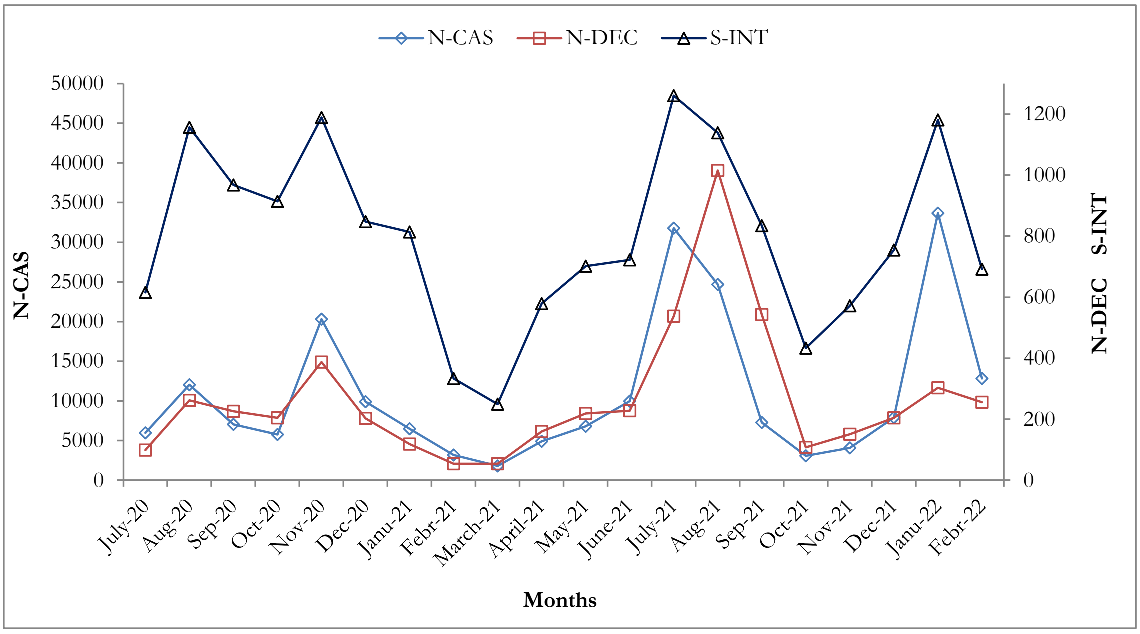


Figure 1. Number of new cases, new deaths and cases in intensive care during the period 17 July 2020 -28 February 2022. N-CAS: number of new cases; N-DEC: number of new deaths; S-INT: number of cases in intensive care.

Correlation between the Number of New Confirmed Cases, New Deaths and Cases in the Intensive Care

The obtained results revealed a non significant linear dependence ($R^2<0.5$) between the number of new confirmed cases (N-CAS) and the number of new deaths (N-DEC) ($R^2=0.425$) as well as between the number of new deaths and the number of cases in the intensive care (S-INT) ($R^2=0.418$). A significant linear dependence ($R^2>0.5$) between the new confirmed cases and the cases in the intensive care ($R^2=0.638$) (Table 2) exhibiting a moderate effect size.

Table 4. Matrix of Pearson correlation between the three variables N-CAS, N-DEC and S-INT

	N-CAS	N-DEC	S-INT
N-CAS	1.000		
N-DEC	0.652*	1.000	
S-INT	0.799*	0.647*	1.000

Marked correlations are significant at $p<0.05$; N-CAS: number of new cases; N-DEC: number of new deaths; S-INT: number of cases in intensive care

Analysis of Principal Component

Repartition of Individual Data on the Two Principal Components

The repartition of individual monthly data on a factorial plan (1x2) is represented in Figure 2. We observed the presence of grouped months against separated months. The grouped months: July 2020, September and October 2020, December 2020 until June 2021, October 2021 until December 2021 and February 2022 are privileged by the same characteristics in terms of number of N-CAS, number of N-DEC and number of S-INT. Concerning the separated months: August 2020, November 2020, July, August and September 2021 and January 2022, they are characterized by numbers of N -CAS, N-DEC and S-INT that differ considerably from the rest of months. August 2020, November 2020 and July 2021 were marked by an increase in the number of INT-C with 1157, 1189 and 1261 cases respectively. August 2021 was characterized by high numbers of the three variables; 24688 N-CAS, 1015 N-DEC and 1139 S-INT. September 2021 was the second month recording high number of N-DEC (543 cases) after August 2021 (1015 cases). January 2022 was marked by the highest number of N-CAS with 33685 cases.

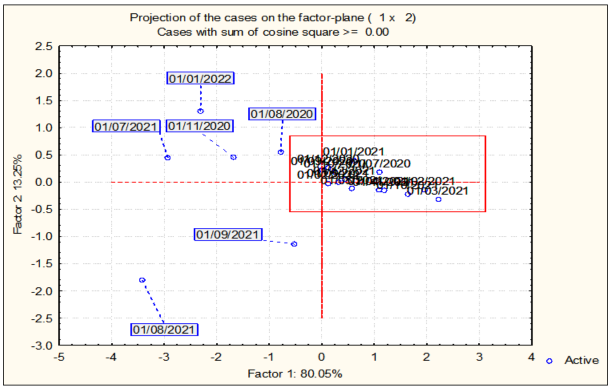
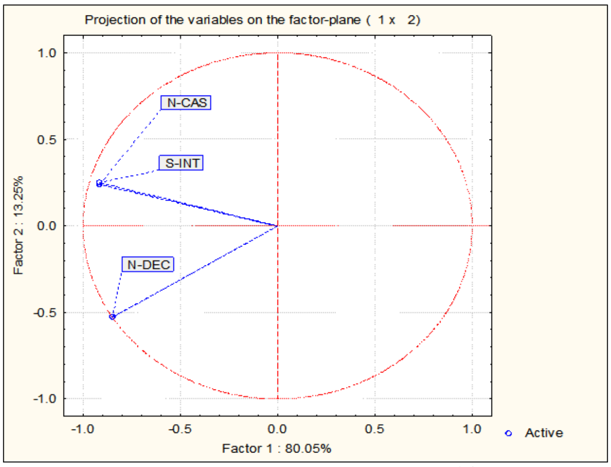


Figure 2. Projection of individual monthly cases on a factorial plan (1×2)

Correlation Circle of the Three Variables

The correlation circle in Figure 3 allows us to see the relation between the three variables N-CAS, N-DEC and S-INT. The numbers of N-CAS and S-INT are two grouped and strongly positively correlated variables. The increase or the diminution of N-CAS leads to a significant increase or a significant diminution of S-INT. The number of N-DEC is an isolated variable and weakly correlated with the numbers of N-CAS and S-INT. The number of N-CAS and S-INT are two variables independent of the number of N-DEC. The increase or the decrease of N-DEC is not related with the number of N-CAS or S-INT.



N-CAS: number of new cases; N-DEC: number of new deaths; S-INT: number of cases in intensive care

Figure 3. Correlation circle of the three variables

Discussion

In this study we underlined the monthly evolution of the pandemic COVID-19 in Algeria regarding the number of new confirmed cases, the number of deaths and the number of cases hospitalized in intensive care, during a period extending from 17 July 2020 until 28 February 2022. Algeria as all the countries of the world was also affected by the pandemic COVID-19. In fact, it is the fourth African country touched by this pandemic [27]. The obtained results show that the monthly accumulation of new cases reached its peaks the months of November 2020, July 2021 and January 2022 (Figure 1). Effectively during the study period Algeria was exposed to a second wave of COVID-19 from September 2020 until April 2021. It was more dangerous than the first wave and characterized by the incapability to control the situation, where more deaths were recorded in particular during the month of November 2020 [28]. This increase in the number of new cases is explained by the back -to- school, mainly after the lifting of the quarantine in 19 provinces, the return of the public transport and the commercial activities in most of the country which facilitated the contact between persons and increased the gatherings. According to WHO [29], the virus is easily transmitted between persons who are in close, generally less than a meter. The persons working in closed environments have a high risk to transmit the virus.

From July 2021, Algeria has known a third wave of COVID-19. It was characterized by two phenomena: the introduction and the quick transmission of the variant DELTA, responsible of 71% of cases, with lack of oxygen in most of the Algerian hospitals [30], which led to an increase of the number of new cases during the month of July 2021 as well as the number of new deaths during the month of August 2021 (Figure 1) and the CFR ration during the month of September 2021, due to the displacement of persons during the summer season. Some *In Vitro* epidemiological and statistical studies have demonstrated the role of humidity and room temperature in the survival and the transmission of respiratory viruses, they have shown that the virus spreads quickly in temperate climates [31,32]. Virus survival and transmission is highly efficient in a dry environment with low relative humidity, and also in a wet environment with high relative humidity, and it is minimal at intermediate relative humidity [33].

From December 2021 until January 2022, the numbers recorded of COVID-19 contamination increased significantly, this has announced the beginning of the fourth wave in Algeria. The month of January 2022 recorded the highest level of new confirmed cases, because of the quick propagation of the variant OMICRON, which represented 57% of cases recorded on 20 January 2022 [34]. On the global epidemiological level, the variant OMICRON is less dangerous than the variant DELTA, the majority of the recorded cases are benign [35] and the CFR decreased to 0.9.

The number of cases in intensive care reached its peaks the months of August 2020, July 2021, November 2021 and January 2022 (Figure 1). According to a study conducted in the university hospital of Tizi Ouzou Algeria, the patients admitted to intensive care were mainly those whose main age was 66 years. Cormobidities were common in this population, dominated by diabetes type 2 (63.04 %), high blood pressure, bronchial asthma, chronic obstructive pulmonary disease and chronic renal failure. Most of the admitted patients to intensive care (62.95%) were smokers [21].

The analysis of principal components (PCA) (Figure 2) by projection of the individual data on a factorial plan (1x2), revealed that the months of August and November 2020, July, August and September 2021 and January 2022 are the most critical periods of the pandemic COVID-19 in Algeria. They are characterized by high levels of new confirmed cases, new deaths and/or cases in the intensive care.

The calculation of the determination coefficient R^2 revealed a significant linear dependence between the number of new confirmed cases and the number of cases in the intensive care at $p<0.05$. The linear dependence between the number of new cases and the number of new deaths as well between the number of the new deaths and the cases in the intensive care was however non significant. These results were confirmed by the correlation circle of variables (Figure 3) where the arrows of N-CAS and N-DEC are superposed [36]. This is explained by the fact that COVID-19 takes time to manifest and to develop complications. In fact, the mean duration of symptoms before hospitalization in the intensive care is almost one week [37-38]. The patients hospitalized in intensive care don't necessarily die. Benhoucine [21] however demonstrated that 78% of patients in the reanimation unity of Tizi Ouzou hospital die, contrary to Wu et al. [39] who recorded low levels of death (21%) among Chinese patients in intensive care.

Since the apparition of the pandemic COVID-19, the authorities have adopted strict preventive measures from 09 March 2020 which consist of the prohibition of international and national travels, the limitation of public gatherings and the isolation and confinement of suspected persons [40]. These measures have contributed to the limitation of SARS-CoV-2 transmission as well as the number of deaths which did not exceed 1015 cases/month in comparison with other countries of the world.

Indeed, using PCA analysis, we could determine the critical periods of the pandemic in Algeria as well as the impact of the number of new cases on the number of cases in intensive care and cases of new deaths which may help in establishing an effective COVID-19 prevention program. Major limitation of this study is the lack of data concerning the number of cases in intensive care at the beginning period of the pandemic in Algeria. Future updates of the study could benefit from the use of other variables and cover a larger period of the study. To better understand the evolution of the pandemic in Algeria, it is recommended to study: a) the relation between the three variables N-CAS, N-DEC, S-INT and the sanitary conditions of the patients as well as their age; b) the evolution of the pandemic in each province; and c) the relation between the evolution of the pandemic and the vaccination rate.

Conclusions

The projection of the individual data on a factorial plan (1×2) revealed that the months of August and November 2020, July, August and September 2021 as well as January 2022 were significant periods of the pandemic COVID-19 in Algeria. The linear dependence between the number of new confirmed cases and the number of cases in the intensive care was significant ($R^2>0.5$, $p<0.05$). This relationship was confirmed by the PCA analysis. In fact, the impact of COVID-19 in Algeria was not really severe due the limited number of deaths (not more than 1015 cases/month) despite the important increase of new confirmed cases.

List of abbreviations

N-CAS- New cases
N-DEC-New deaths
S-INT-Cases in the intensive care

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

ZC carried out the analysis and discussion of results. SH performed the statistical treatment of data. BK and NK participated in the bibliographic discussion of data. All authors read and approved the final manuscript.

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