Two years of Covid-19 pandemic : A higher prevalence of the disease was associated with higher geographic latitudes, lower temperatures, and unfavorable epidemiologic and demographic conditions.

Mourad ERRASFA*
***Department of Pharmacology, Laboratory of Epidemiology and Research in Health Sciences, Faculty of Medicine and Pharmacy, Sidi Mohamed Ben Abdellah University, Fez, Morocco.**
Email : mourad.errasfa@usmba.ac.ma

ABSTRACT

Background : The Covid-19 pandemic associated with the SARS-CoV-2 has caused very high death tolls in many countries, while it has had less prevalence in other countries of Africa and Asia. Climate and geographic conditions, as well as other epidemiologic and demographic conditions, were a matter of debate on whether or not they could have an effect on the prevalence of Covid-19.

Objective : In the present work, we sought a possible relevance of the geographic location of a given country on its Covid-19 prevalence. On the other hand, we sought a possible relation between the history of epidemiologic and demographic conditions of the populations and the prevalence of Covid-19 across four continents (America, Europe, Africa, and Asia). We also searched for a possible impact of pre-pandemic alcohol consumption in each country on the two year death tolls across the four continents.

Methods : We have sought the death toll caused by Covid-19 in 39 countries and obtained the registered deaths from specialized web pages. For every country in the study, we have analysed the correlation of the Covid-19 death numbers with its geographic latitude, and its associated climate conditions, such as the mean annual temperature, the average annual sunshine hours, and the average annual UV index. We also analyzed the correlation of the Covid-19 death numbers with epidemiologic conditions such as cancer score and Alzheimer score, and with demographic parameters such as birth rate, mortality rate, fertility rate, and the percentage of people aged 65 and above. In regard to consumption habits, we searched for a possible relation between alcohol intake levels per capita and the Covid-19 death numbers in each country. Correlation factors and determination factors, as well as analyses by simple linear regression and polynomial regression, were calculated or obtained by Microsoft Exell software (2016).

Results : In the present study, higher numbers of deaths related to Covid-19 pandemic were registered in many countries in Europe and America compared to other countries in Africa and Asia. The analysis by polynomial regression generated an inverted bell-shaped curve and a significant correlation between the Covid-19 death numbers and the geographic latitude of each country in our study. Higher death numbers were registered in the higher geographic latitudes of both hemispheres, while lower scores of deaths were registered in countries located around the equator line. In a bell shaped curve, the latitude levels were negatively correlated to the average annual levels (last 10 years) of temperatures, sunshine hours, and UV index of each country, with the highest scores of each climate parameter being registered around the equator line, while lower levels of temperature, sunshine hours, and UV index were registered in higher latitude countries. In addition, the linear regression analysis showed that the Covid-19 death numbers registered in the 39 countries of our study were negatively correlated with the three climate factors of our study, with the temperature as the main negatively correlated factor with Covid-19 deaths. On the other hand, cancer and Alzheimer's disease scores, as well as advanced age and alcohol intake, were positively correlated to Covid-19 deaths, and inverted bell-shaped curves were obtained when expressing the above parameters against a country's latitude. Instead, the (birth rate/mortality rate) ratio and fertility rate were negatively correlated to Covid-19 deaths, and their values gave bell-shaped curves when expressed against a country's latitude.

Conclusion : The results of the present study prove that the climate parameters and history of epidemiologic and demographic conditions as well as nutrition habits are very correlated with Covid-19 prevalence. The results of the present study prove that low levels of temperature, sunshine hours, and UV index, as well as negative epidemiologic and demographic conditions and high scores of alcohol intake may worsen Covid-19 prevalence in many countries of the northern hemisphere, and this phenomenon could explain their high Covid-19 death tolls.

Keywords : Covid-19, Coronavirus, SARS-CoV-2, climate, temperature, sunshine hours, UV index, cancer, Alzheimer disease, alcohol.

INTRODUCTION

The Covid-19 pandemic was declared two years ago following high death tolls caused by SARS-CoV-2 infections around the world [1]. The virus and its target human cell receptor ACE-2 were identified [2, 3]. SARS-CoV-2-infected people can experience mild to moderate symptoms, such as muscle pain, headaches, loss of smell and taste, diarrhea, and more severe symptoms, such as

breathing difficulties. The better understanding of the pathophysiology of covid-19 [4-8] made it possible to achieve good therapeutic management of the Covid-19 patients, based on anti-inflammatory corticoids, antibiotics, and blood thinners against inflammatory conditions (cytokine storm), infections, and microcoagulations, respectively [9,10]. Other adjuvant treatments [11–13] were used as well, such as immune-boosting vitamins (vitamin C, vitamin D), minerals (zinc and magnesium) and probiotics/prebiotics products.

Countries in Europe and America have suffered elevated death tolls caused by SARS-CoV-2 during the last two years. Severe cases of the disease included obese patients and patients with comorbidities (cardiovascular and neurovascular diseases, chronic renal failure, diabetes, and cancer patients) [14-16]. A question about whether or not climate parameters and/or the epidemiologic and demographic history of patients may have played a role in the prevalence of the disease has caught the attention of researchers since the beginning of the pandemic. Several studies have pointed out a negative relationship between some climate factors such as ambient temperature and coronavirus incidence and/or Covid-19 [17-25]. A recent study has classified Covid-19 as a possible seasonal low-temperature infection [26].

On the one hand, the low incidence of Covid-19 mortality in many countries in Africa [27] compared to those of Europe and America caught our attention. On the other hand, death tolls caused by Covid-19 in countries of North Africa were somehow higher than those registered in countries of central Africa. It was suggested by many scientists that Covid-19 prevalence could be modulated by the immune status [28,29], demographic, epidemiologic and nutritional conditions [30-32]. Excessive alcohol intake was shown to be associated with many cancers [33]. The aim of the present observational study was to analyze the COVID-19 deaths after two years of the pandemic in 39 countries and to check if some specific climate parameters or other epidemiologic or demographic factors may distinguish a given geographic area with regard to the vulnerability of the population to the Covid-19 disease.

MATERIALS AND METHODS :

We obtained Covid-19 death numbers [33-36], climate factors data [37-41], epidemiologic data [42], demographic data [43-45], and alcohol intake per capita [46] from officially published documents. Specialized websites were obtained from the pages of specialized The data, correlation parameters, linear regression, polynomial regression, and figures were processed and

analyzed by the Microsoft Office Excel software (2016). The cancer score was estimated as the number of cancers reported in the table of the ten most common causes of death in each country as published by the IMHE and WHO [42]. The Alzheimer disease score was estimated as "11 minus the ranking order of Alzheimer's disease among the 10 causes of death in each country [42]. When Alzheimer's disease was not listed, the score was "0". The advanced age score was considered as the percentage of people aged 65 years and above [43-45]. The alcohol intake score was considered as the annual rate of alcohol consumption per capita for people aged over 15 [46].

RESULTS :

Two years of the Covid-19 pandemic have caused high tolls of deaths in many countries of Europe and America compared to other countries in Africa and Asia. From the very beginning of the pandemic, a question was raised about whether some geographic climate factors or other factors related to each individual, such as health history and age, may have played a role in the vulnerability of people and in the general prevalence of the disease.

We have checked the climate parameters (annual average of temperature, hours of sunshine, and UV index) of 39 countries, distributed as follows : North America (United State and Mexico), South Amercia (Brazil, Colombia, Argentina and Chile), Europe (France, Italy, Spain, Germany, Portugal, United Kingdom, Estonia, Lithuania, Croacia, Serbia, Poland, Romania, North Macedonia, Latvia and Ukraine), Africa (Morocco, Argelia, Mauritania, Tunisia, Egypt, Sudan, Congo, Senegal, South Africa, Mali and Libya), Asia (Isreal, Saudi Arabia, India, Iran, Indonesia, Philippine and Jordan). The population of the above countries is a sample of 3525 million people; a 44.43 percent of the total world population. As shown in Figure 1, 32 of the above countries are located in the northern hemisphere (2887 million people, representing 82% of our sample population), and among them, 26 countries are located on the west side of the meridian longitude line (2527 million people). The analysis by polynomial regression generated an inverted bell-shaped curve and a significant correlation between the Covid-19 death numbers and the geographic latitude of each country in our study (Figure 2A). Higher death numbers were registered in the higher geographic latitudes of both hemispheres, while lower scores of deaths were registered in countries located around the equator line. In a bell shaped curve, the latitude levels were negatively correlated to the average annual levels (last 10 years) of temperatures

(Figure 2B), sunshine hours (Figure 2C) and UV index (Figure 2D) of each country, with the highest scores of each climate parameter being registered around the equator line, while lower levels of temperature, sunshine hours, and UV index were registered in higher latitude countries. In addition, the linear regression analysis showed that the Covid-19 death numbers registered in the 39 countries of our study were negatively correlated with the three climate factors of our study, with temperature as the main negatively correlated factor with Covid-19 deaths (Figure 3, A-C).

Other epidemiologic and demographic factors were searched in the 39 countries, as well as the level of alcohol consumed per capita in 2019. Inverted bell-shaped curves were obtained by polynomial regression when the latitude was plotted against either (cancer score + Alzheimer score), advanced age, or alcohol intake per capita (Figures 4, panels A, B, and C). Interestingly, all the above parameters were positively correlated to Covid-19 death numbers (Figures 4, panels D, E, and F). In contrast, bell-shaped curves were obtained by polynomial regression when the latitude was plotted against both the (birth rate/mortality rate) ratio (Figure 5, panel A) and the fertility rate (Figure 5, panel B). The above parameters were negatively correlated to Covid-19 death numbers (Figure 5, panels C and D).

DISCUSSION

The fact that Covid-19 death tolls across the continents differed from one country to another led many scientists to search for possible causes of that. Climate factors and factors related to the history of epidemiologic and nutrition parameters as well as demographic factors were questioned [17-26]. In the present observational study, the case of low Covid-19 impact in both central Africa and the northern part of the continent was clearly different from what happened in Europe and America during the two years of the pandemic. We therefore hypothesize that the low Covid-19 mortality in Africa and Asia may have had some relationship with climate factors and/or epidemiologic and demographic conditions far before the beginning of the Covid-19 pandemic. Previous studies [17–26] have reported the possible impact of climate (mainly the average temperature) on the coronavirus incidence and/or mortality caused by Covid-19. In the present observational study, we confirm that climate factors, and mainly temperature, were very correlated to the number of deaths across 39 countries in the world. Our sample of countries covered more than 44% of the total population of the world. The average annual hours of sunshine and the UV index were also linked to COVID-19 deaths. Similarly, low temperatures and

low hours of sunshine and UV index in the countries located in the very north of the earth may be negative climate conditions to fight the Dovid-19 disease and/or the SARS-Cov-2, or they maye ase the spread and incidence of the virus.

On the other hand, we know from the epidemiologic data of the Covid-19 pandemic that people with risk factors (obesity, advanced age, chronic diseases such as cardiovascular, brain diseases, chronic renal failure, diabetes, and cancers) may have a greater risk of dying from the coronavirus infection [4]. Hence, the health history of every individual might be a key point in the outcome of coronavirus infetion. Our data on the geographic prevalence of cancer and Alzheimer's disease and their correlation to Covid-19 deaths supports the idea that countries with higher scores of both diseases may have suffered a bad outcome for Covid-19, and the results show that countries with lower scores of cancer and Alzheimer's disease have registered fewer Covid-19 deaths in both hemispheres of the earth. Thus, the good correlation between both latitude and (cancer + Alzheimer score) and between (cancer + Alzheimer score) and Covid-19 deaths is a reliable and significant statistical event. Alcohol intake is a risk factor for many cancer types and diseases. In the present observational study, we have demonstrated that the level of alcohol intake was very correlated to the latitude levels of high-consumer countries. Indeed, alcohol consumption was correlated to Covid-19 death numbers. This result supports the hypothesis that a history of heavy alcohol intake may worsen Covid-19 outcomes and Covid-19 deaths.

Finally, demographic factors point to the fact that Covid-19 deaths were very lower in countries where the percentage of elderly people is low, and where the ratio of (birth rate to mortality rate) and the fertility rate are higher. This is no surprise, as most Covid-19 deaths were not registered among younger people. Countries with a higher percentage of young people, such as African countries, have suffered much less from the Covid-19 pandemic.

In North Africa, some countries like Morocco seem to have an intermediary pandemic situation between Africa and Europe, since the death numbers caused by Covid-19 were lower than those registered in neighboring European countries such as Spain and Italy. Hence, independently of the vaccinations, for both the first and second years of the pandemic, it seems that climate factors, mainly warmer daily temperatures and longer hours of sunshine

in African countries, could have played a key role in the low incidence of the coronavirus and Covid-19 disease in those countries.

CONCLUSION:

The data from the present study supports the hypothesis that warmer ambient temperatures are favorable for better protection against the coronavirus. Low temperatures and a negative epidemiologic and demographic history of countries at higher latitudes (primarily those in the northern hemisphere, which is home to more than 88% of the world's population) may have played a role in the high COVID-19 death tolls in many European and American countries.In the above countries, heavy drinkers may also have had a bad outcome from coronavirus infection. Finally, regardless of the vaccination process, natural parameters led by latitude location and the history of epidemiologic, demographic, and nutritional habits may have played a key role in the vulnerability of the population.

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