# Pre-pandemic scores of epidemiologic and demographic parameters highly correlate with Covid-19 death mortality in Western Europe and North Africa

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**On the first anniversary of the COVID-19 pandemic, thousands of deaths were registered around the world, however, some countries suffered more than others in incidence and mortality caused by the SARS-CoV-2 coronavirus.**

**We have sought the pre-academic epidemiologic and demographic parameters (2019) of several countries of Western Europe and North Africa in the present work. Large differences in COVID-19 mortality were observed between European and African countries. The results of our analyses show a positive correlation between some parameters (cancer, Alzheimer's disease, advanced age, and alcohol intake) and Covid-19 mortality. On the other hand, there was a negative correlation between some demographic parameters (annual birth rate, mortality, and fertility rate) and Covid-19 mortality. Upon a stepwise multiple linear regression analysis of our data, we have selected two linear regression equations whose variables were (birth rate/mortality rate) ratio, fertility rate and cancer score. The above equations gave close predicted Covid-19 mortality to registered mortality in Western European and North African countries.**

Keywords: Covid-19, Coronavirus, SARS-CoV-2, epidemiology, demography, birth rate, fertility rate, alcohol intake, multiple linear regression.

## Introduction

Since the Covid-19 pandemic was declared early 2020, there have been a significant number of publications on SARS-CoV-2) and Covid-19 pathophysiology (1).

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

difficulty to breathing, which may endanger the life of the patient if the treatment is not properly configured. In the absence of a specific antiviral against SARS-Cov-2, the treatment of patients has often been prophylactic, directed against infections, inflammatory conditions (cytokine storm) and microcoagulations. Vitamins (C, D, B) and mineral salts (magnesium, selenium, zinc) have also been prescribed as support therapy, as well as probiotics (1).

After one year of pandemic, it was possible to make an evaluation of certain epidemiological and demographic data of the pre-pandemic phase and check their usefulness in Covid-19 mortality. Several Western European countries (United Kingdom, Germany, France, Italy, Spain, Portugal) have registered high Covid-19 mortality rates compared to some neighboring countries in North Africa (Morocco, Algeria, Libya, Tunisia, Mauritania). The purpose of this study was the analysis of possible factors that could explain such differences in Covid-19 mortalities (2).

**Materials and Methods:**

We obtained Covid-19 data, epidemiologic and demographic trends from specialized websites for population and health statistics (3-8). Correlation analysis of demographic, epidemiologic and alcohol intake data were carried out using the Pearson's Coefficient. Covid-19 mortality and the rest of demographic and epidemiologic data were analyzed using a stepwise multiple linear regression (Microsoft's Excel 2007). All epidemiologic and demographic data analyzed in the present study were of 2019. Alcohol consumption data were from a survey of 2016 (9). Cancer score was estimated as the number of cancers reported in the table of ten most cause of death published by the IMHE and WHO (2,3). Alzheimer's disease score was estimated as 11 minus the ranking order of Alzheimer disease among 10 cause of death of each country. When Alzheimer's disease was not listed, the score was "0". Advanced age score was considered as the % of people aged 65 years and above. Alcohol intake score was considered as the annual rate of alcohol consumption per capita for individuals of 15 years and above (9).

An **Epidemiologic and Demographic Risk Factor (EDRF)** for Covid-19 is proposed in the present study. It is aimed to emphasizing in a given country to weigh the burden of cancer, Alzheimer's disease and advanced age (positively correlated parameters to Covid-19 mortality) and also it takes into account the ratio (birth rate/mortality rate) and fertility rate (negatively correlated parameters to Covid-19) in the same country as well. EDRF is expressed as follows:

EDRF= (Cancer score + Alzheimer score) + advanced age score / (Birth Rate / Mortality Rate) + Fertility rate.

## Results and Discussion

In this study, six Western European countries (Great Britain, Germany, France, Italy, Spain, Portugal) and five North African countries (Morocco, Algeria, Tunisia, Libya, Mauritania) were included. Their demographic data are shown in Tale 1. Differences in the demographic parameters (birth rate, fertility rate, birth rate / mortality rate ratio and log of (% people aged 65 and above) and alcohol consumption are very significant between Western European and North African countries as shown in Table 2.

As a key parameter of Covid-19 incidence, we considered the cumulative number of deaths of each country during the first year of the pandemic (March 1st, 2020 to March 22, 2021). The mortality curves of Western European countries as well as those of North African countries showed some parallelism from the beginning of the pandemic. There was a first phase (first wave) of four months (March, April, May, June 2020) with a peak at mid-April. We can consider that there has been a second phase that extended from mid-August to March 22, 2021, where the majority of deaths in the first year of the Covid-19 pandemic occurred.

Figure 1 shows the annual mortality rate for 2019 in each country of the present study (Figure 1 left panel) and the mortality rate caused by Covid-19 (Figure 1 right panel). The figure shows a higher 2019 annual mortality in Western European countries compared to North African countries. Covid-19 mortality in Western European countries was significantly higher than in North African countries.

Birth rate and fertility rate were significantly lower in Western European countries compared to the countries of North Africa (Figures 2 and 3, left panels). Birth rate and fertility rate were negatively correlated to Covid-19 mortality (Figure 2 and 3, Right panels). The (birth rate-to-death rate) ratio in Western European countries was very low in Western European countries compared to North African countries, and it was highly correlated to Covid-19 mortality (Figure 4). The parameter (birth rate X fertility rate) was negatively and highly correlated to Covid-19 mortality (Figure 5).

The Covid-19 mortality was higher in elderly and nursing homes of several European countries. Thus, advanced age was considered as a risk factor for Covid-19 (10). The percentage of people aged 65 and above was higher in Western European countries compared

to North African countries (Figure 6), and it was positively and highly correlated to Covid-19 mortality.

According to epidemiologic data published by IHME and WHO (2,3), the list of the 10 most causes of death in Western European countries are quite similar and correspond to the profile of high income countries. Most chronic diseases are shared (heart failure, stroke, chronic obstructive pulmonary disease, hypertension, diabetes and renal insufficiency) by both European and North African countries, nevertheless, the ranking of each disease differs from a country to another. Instead, two main disease conditions; namely cancer and Alzheimer disease are described as serious risk factors for Covid-19. Hence, we have selected the above two pathologies to analyze their relationship to Covid-19 incidence in our study.

Figure 7 (left panel) shows that cancer score was much higher in Western European countries in 2019 compared to North African countries, mainly in the UK (scores 5) and France (scores 4). Cancer score was correlated to Covid-19 deaths (Figure 7, right panel). Similarly, the incidence of Alzheimer's disease has been very high in Western Europe compared to North African countries, and it was correlated to Covid-19 mortality (Figure 8). These results confirm the importance of cancer and Alzheimer's disease in the high scores of Covid-19 mortality in Western Europe.

Covid-19 mortality and the above demographic and epidemiologic data, as well as alcohol intake were analyzed with a stepwise multiple linear regression. The results gave two main equations that highly predicted Covid-19 mortality in Western Europe and North Africa's countries. The summary outputs of the stepwise linear regression analysis are shown in Table 3. Equation 1 uses cancer score and the ratio (birth rate/mortality rate). It is expressed as ($Y= a_1X1 + a_2X2 + b$; **Covid-19 mortality = 0.179 (Cancer score) - 0.225 (birth rate/mortality rate) +1.095**). Equation 2 is expressed as ($Y= a_1X1 + a_2X2 + b$; **Covid-19 mortality = -0.136 (birth rate) + 0.650 (fertility rate) + 1.633).**

We have developed a ratio of positively and negatively correlated parameters to Covid-19 that we called Epidemiology and Demography Risk Factor (EDRF) whose parameters were indicated is the Methods. EDRF values of the eleven countries of our study were very high in Western European countries compared to North Africa countries (Figure 9, left panel). A high Pearson correlation (R= +0.891) was found between EDRF and Covid-19 mortality. Output of the linear regression analysis of Covid-19 mortality and EDRF is depicted in table 3 (Equation 3, expressed as **(Y = aX+ b; Covid-19 mortality = 0.33 (EDRF) + 0.145).**

Thus, both equation 1 and 2, as well as the EDRF's equation 3 gave predicted Covid-19 mortalities very close to registered Covid-19 mortality as shown in Table 4. This data show the capacity of equations 1 and 2 to predict Covid-19 mortality on one hand, on the other hand, EDRF's equation 3 not only predicted Covid-19 mortality, but it also can give an estimation of the vulnerability of a given population to Covid-19. Indeed, European countries have had elevated values of EDRF compared to North African countries (Figure 9).

A 2016 survey of Alcohol consumption showed high scores in the Western European countries compared to African countries (Figure 10). We found that alcohol consumption was highly correlated to Covid-19 mortality (Figure 10, left panel) and to cancer scores (Figure 11).

Ceuta and Melilla are two Spanish cities located in the north of Morocco whose populations are 50% of North African ethnicity, and they have many Moroccan nutritional and social habits. Both cities have had low Covid-19 mortality compared to the rest of the main land Spanish cities. We have calculated their predicted Covid-19 deaths using equation2. The equation gave predicted numbers of deaths very close to the registered Covid-19 death numbers of both Ceuta and Melilla (Table 5). It is relevant to mention that the demographic data of Ceuta and Melilla are similar to those of Morocco, and that may be explained by the high percentage (around 50%) of the population of North African ethnicity in Ceuta and Melilla, and its social and nutritional similarity to the Moroccan population.

In conclusion, the present study demonstrates that Covid-19 mortality was significantly correlated to pre-pandemic demographic and epidemiologic conditions in Western Europe and North Africa. Stepwise multiple linear regression analysis showed that equations based on birth rate, fertility rate and cancer score can predict Covid-19 mortality. On the other hand, the EDRF, a risk factor that we proposed as an indicator of a country's health risk also predicted Covid-19 mortality. EDRF would represent an "iceberg" of possible factors that may decrease immune capacity of an individual. EDRF might be influenced by several parameters, such as genetic, nutritional, social and cultural habits of a population.

In light of the results of the present study, populations of North Africa could consider to relaxing their safety measures in order to recover a better social and economic activities, while Western European countries should take serious safety measures before all population at risk get vaccinated.

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