Acta Biomed 2021; Vol. 92, N. 1: e2021022 DOI: 10.23750/abm.v92i1.10090

A cluster analysis of epidemiological and clinical factors associated with the accumulation process of the burden of COVID-19 in European countries

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Abstract. *Background and aim of the work:* European COVID-19 statistics showed differentiation between mortality and new cases. Some studies suggested several factors including migration, cancer incidence, life expectancy and health system capacity maybe associated with differentiations. Up to now, impact of those factors in different European societies is not discussed and compared. Aim of the present study was to perform the cluster analysis in European countries in attention to clinical and epidemiological factors due to covid-19. *Methods:* We collected some appropriate extreme data of COVID-19 to access the situations by ANOVA post-hoc test in 3 scenarios, as well as to estimate regression coefficients in simple linear regression, and a cluster analysis using average linkage. The present study was designed to assess the situation in the European region in the face of COVID-19 from the beginning of the conflict to April 24, 2020. *Results:* Among 39 European countries, several countries reported highest rate of confirmed cases included of Italy (current statues=2270.52) and Spain (current status=2616.24). The highest rate of mortality was seen in France (current status=242.16), Italy (current status=305.52). Life expectancy (female) (P=0.01, 95%Cl=1521.27,15264.58), migration (P<0.001, 95%Cl=41.42,96.72) had significant association with confirmed cases and death. Overall cancer death (P<0.001, 95%Cl=0.36,0.68; P<0.001, 95%Cl=0.01,0.07) and lung cancer death (P<0.001, 95%Cl=1.97,3.56; P<0.001, 95%Cl=0.09,0.37) associated with confirmed cases and mortality, too. We were also determined 5 clusters which more than 30 countries were categorized in the first cluster. *Conclusions:* Demographic factors, including population, life expectancy and migration, underlying disorders, such as several types of cancers, especially lung cancers lead to various distribution of COVID-19 in terms of prevalence and mortality, across European counties. (www.actabiomedica.it)

Keywords: European Countries, Clinical Factors, Epidemiological Factors, COVID-19, Cluster Analysis

Introduction

On December 31, 2019, due to the finding of some cases of unknown pneumonia in Wuhan City, China, the World Health Organization (WHO) alerted the world about a new emergency in this country (1). The unknown pneumonia was accompanied with other signs and symptoms, as well as with fever, anosmia, cough, headache, and others, and was finally recognized as a new type of coronavirus (COVID-19)

(2). Within a month, this organization described this respiratory disease as a global concern, due to the detection of numerous cases outside China (1). Until early March, many countries struggled with COVID-19. Therefore, on March 11, WHO described the situation as a global pandemic (3, 4). However, before this announcement, COVID-19 was spread among many countries and entered other continents including Europe (5). On January 24, 2020, France was the first European country that officially confirmed the entry of the disease into Europe, and on February 15, the first death in Europe was reported in this country (5). Gradually, the number of people suffering from COVID-19 and also COVID-19 deceased people increased in Europe (6). As of July 2020, WHO reported in its 95th Situation Report Factsheet approximately 10 185 374 confirmed cases and also 503 862 deaths in the European Region (7). Although, the distribution of new cases and mortality was different among countries in the region (7).

The difference in statistics probably indicates the impact of various factors on the disease. In a study, the overall mortality rate from COVID-19 was estimated at 0.66%, while it was estimated at 7.8% over the age of 80 years. Moreover, hospital admission was reported to be about 20 times higher in people over 80 years of age than in people under 30 years of age (8, 9). These data indicate the potential importance of population pyramids and the role of social structures, as well as age, fertility, and life expectancy in the prevalence and mortality of this disease. Other research also showed an increase in the need for ICU and ventilators during this crisis (10), which may indicate the role of health system infrastructures in the mortality of these patients. On the other hand, many studies showed that more mortality occurred in patients with comorbidities including diabetes and malignancies (11, 12). In addition, lung cancer, due to the similarity of its symptoms with those of COVID-19, , has probably worsen the condition of patients (13). Therefore, assessment of cancer impacts on COVID-19 is necessary to determine COVID-19 mortality among different nations.

In the current study, firstly, we intended to compare the statistical significance between countries in three different scenarios about to the number of confirmed and death cases separately for the European population. Secondly, we attempted to estimate the impact of several demographic, therapeutic, clinical, and quality of life factors on confirmed and death cases using simple linear regression. Ultimately, we conducted a hierarchical cluster analysis on the 39 European countries according to demographic and geographic features, life expectancy, confirmed and death cases due to COVID-19, and some other factors to clarify their impact on COVID-19 mortality and prevalence.

Methods

Study Design and Data Gathering

The present study was designed to assess the situation in the European region in the face of COVID-19 from the beginning of the conflict to April 24, 2020. A Short time after the conflict, the World Health Organization (WHO) began collecting and reporting cases around the world. The data of the present study were collected and updated day-to-day from a package in R software called Rami Krispin (14) based on the statistics of the WHO. This package has an information includes the number of confirmed cases along with the number of deaths and recovery for each country with a unique longitude and latitude. Next, using another package called wppExplorer (15), we extracted data of population and life expectancy separately for men and women, as well as age information including middle age, child dependency ratio, potential support ratio, and some other data were estimated for year of 2020. Then for getting access to cancer incidence and death data (16), as well as to find information about hospital equipment and medical staff (17), and finally to estimate the indexes of quality of life, safety, health care, and cost of living (18), we used such as validated internet sites that it contains this information. Any country with more than 100 cases, as well as had reliable registered records of our searches, was added to the study. Finally, this data needs to be combined for European countries in order to analyze and achieve the desired goals.

Statistical Analysis

Statistically significance between countries in the number of confirmed and death cases was done with the ANOVA test. Then, using Duncan's post-hoc test, multiple comparisons were made to examine the differences between them. These comparisons were made in 3 scenarios. The first scenario involves the first completed month of each country after the first confirmed or death case due to COVID-19 has been found. The second scenario involves the second completed month of each country after the first case of COVID-19 has been found. And the last scenario involves the current situation regardless of elapsed month since identifying the first case. Also, by applying simple linear regression, we estimated the effect of each study factor once by the number of confirmed and then by deaths related to covid-19. Finally, using the factors obtained from the R software (for which the missing data for these factors are not observed in any country), we performed a hierarchical cluster analysis. Cluster analysis divides data objects into clusters that share common characteristics and are based only on information objects and their relationships. Clusters are potential classes with common characteristics, and cluster analysis is the study of techniques for finding optimal classes. In this study, we performed a hierarchical cluster analysis and selected average linkage and squared eulicidean distance method in European region with the cut point of square root of n/2, which n is the number of observations, i.e. the number of study countries. All statistical analysis was conducted using R, version 3.6.3 and ArcMap, version 10.4.1.

Results

In current study, we determined the numbers of confirmed cases of and death due to COVID-19 among more than 39 Europe countries. After collection of overall data, the numbers were participated based on three different times, including first month, second month of onset and current time. Then, according to the number of confirmed and death patients, the severity of outbreak was determined. A was allocated to mild severity and E for severe form of outbreak. Our result of confirmed cases revealed 18 counties in A group. In first month of disease outbreak. 13 countries belonged to A, B arms simultaneously. In A group, Russia, Sweden, Germany, United Kingdom and Belgium had better situation with 0.07, 0.4, 0.55, 0.77 and 0.77 confirmed cases per day, respectively. In this group, Finland, Greece had worse situation with 31.9, 29.73 confirmed cases per day, respectively. In AB group, Cyprus with 100.3 confirmed cases had worse situation. In first month, Austria with 186.27 and Portugal with 248.1 confirmed cases belonged to BCD and CDE arms, respectively. In first month, Turkey and Switzerland had highest confirmed cases among European countries (1409.4 and 363.23 cases/day, respectively) (Table.1).

In second month, the data for about 11 countries were available. Among them, 8 countries allocated to A group and had better situation. In A group, United Kingdom 747.67 positive patients were recorded during the second month of outbreak in this country. Croatia had better situation in A arm (52.23 confirmed cases/day). Italy had the worsen situation in second

Table 1. Post hoc analysis on confirmed cases by country regions and time to challenging by covid-19

Country Region	First month completed challenging by covid-19*	Second month completed challenging by covid-19**	Current status***
Albania	12.77 A	-	14.43 A
Austria	186.27 BCD	316.1 A	251.18 AB
Belarus	3.13 A	-	153.91 AB
Belgium	0.77 A	558.23 A	546.83 ABC
Bosnia and Herzegovina	19.3 A	-	27.86 A
Bulgaria	18.3 A	-	25.71 A

(Continued)

Table 1. Post hoc analysis on confirmed cases by country regions and time to challenging by covid-19 (Continued)

Country Region	First month completed challenging by covid-19*	Second month completed challenging by covid-19**	Current status***
Croatia	14.73 A	52.23 A	33.48 A
Cyprus	16.47 A	-	17.11 A
Czechia	100.03 AB	-	132.24 AB
Denmark	73.33 AB	-	144.97 AB
Estonia	19.17 A	-	27.67 A
Finland	31.9 A	-	74.47 A
France	0.4 AB	670.37 A	1738.61 D
Germany	0.57 A	1464.03 B	1741.56 D
Greece	29.73 AB	-	42.2 A
Hungary	19.50	-	46.98 A
Iceland	32.1 AB	-	31.39 A
Ireland	87.17 AB	-	324.71 ABC
Italy	37.6 AB	3353.7 C	2270.52 E
Latvia	13.27 A	-	14.52 A
Lithuania	13.13 A	-	24.74 A
Luxembourg	65 AB	-	65.98 A
Moldova	32.17 AB	-	64.79 A
Montenegro	9.6 A	-	8.18 A
Netherlands	288.23 DE	-	633.26 BC
Norway	112.3 ABC	-	126.49 AB
Poland	98.2 AB	-	209.46 AB
Portugal	248.1 CDE	-	422.17 ABC
Romania	34.3 AB	-	176.56 AB
Russia	0.07 A	61.13 A	807.32 C
Serbia	54.13 AB	-	132.6 AB
Slovakia	15.7 A	-	27.2 A
Slovenia	31.13 AB	-	26.92 A
Spain	2.8 A	3194.63 C	2616.24 E
Sweden	0.4 A	133.87 A	206.67 AB
Switzerland	363.23 E	592.67 A	477.95 ABC
Turkey	1409.4 F	-	2331.38 E
Ukraine	26.47 AB	-	153.3 AB
United Kingdom	0.77 A	747.67 A	1701.65 D

* The average of confirmed cases from the date of the first person reported in each country up to one full month elapsed thereafter. As the letters of the alphabet progress from A to F, respectively, the situation of each country worsens in the first month of its exposure to the virus in comparison with other countries.
** The average of confirmed cases from the date of the first person reported in each country up to two full month elapsed thereafter. As the letters of the alphabet progress from A to C, respectively, the situation of each country worsens in the second month of its exposure to the virus in comparison with other countries.
*** The average of confirmed cases without considering the cut point for the date of the first person reported, and of course without considering the number of months or days elapsed; until the end of April 24th. As the letters of the alphabet progress from A to E, respectively, the situation of each country worsens in comparison with other countries.

month of onset with 3353.7 positive cases per day. In current status until 24th April, 17 countries were allocated to A arm. Among them, Montenegro, Albania and Cyprus had better situation with 8.18, 14.43 and 17.11 new cases/day respectively, and Finland had highest number of positive case per day (74.47), in A group. Austria with 251.18 confirmed cases/day had highest number of infected patients in AB group. In current status, Belgium with 546.83 affected by SARS-COV2 belonged to ABC arm and Spain had worsens situation with 2616.24 new cases per day (Table. 1).

Post hoc analysis on death cases by country regions showed in first month, Belgium, Belarus, Germany, Latvia, Russia, Spain, Sweden, United Kingdom reported no mortality. However, Belarus in second month was categorized in A group and its situation had worsened until 24th April and categorized in D arm with 82.46 deceased cases per day. Bosnia and Herzegovina in first month with 0.57 death numbers/day was categorized in AB and now, they had 1.08 death cases/day (A group). Croatia in three times belonged to a group (first month=0.03, second month=1.67, current status= 0.83). The situation in France during the time became worsen. In first month, this country was allocated in A group (0.03 death/day), in second month in A arm (28.7 death/day) and currently in E arm (242.16 mortality cases/day). Finland in first month, had 0.17 death/day. Currently, this number in Finland became 3.01 deceased patients/day. Overall, this country was categorized in A group. Currently, the death number in Germany raised up to 64.72 cases/day. In first month, Italy had 0.97 mortality number/day (ABC), in second month, it reported 385.4 death/day (C) and currently data showed 305.52 deceased cases/day (F) in this country. Netherlands, in first month revealed 18.23 death/day (D) and currently, 74.21 deceased/day (CD) were reported. Portugal had 5.33 number of death/day (C) in first month and currently this number became 15.81 per day (AB). The death cases, in second month in Spain were 282.13, and currently until 24th April, they reported 268.14 death/day (EF). In second month, Sweden reported 4.867 mortality numbers/day (A), in current situation, this number achieved to 25.32 per day (ABC). In first month, turkey had about 30.27 mortality/day (E), and currently 57.78 new mortality cases/day (ABCD) were reported (Table. 2).

Simple regression showed association of several characteristics with confirmed cases. the important ones include longitude (P=0.011, coefficient=-1933.42, Cl 95%=-3398.88, -467.95), life expectancy (female) (P=0.018, coefficient =8392.92, Cl=1521.27, 15264.58), total population (P<0.001, coefficient =1.31, Cl 95%=0.86, 1.75), all cancer incidence (P<0.001, coefficient =0.27 95% Cl=.21, .33), lung incidence (P<0.001, coefficient =2.34, 95% Cl=1.72, 2.96), all cancer death (P<0.001, coefficient =0.52, 95% Cl=0.36, 0.68), lung death (P<0.001, coefficient =2.77, 95% Cl=1.97, 3.56), and health care index (P<0.001, coefficient =2620.96, 95% Cl=501.66, 4740.25). However, personnel like doctors and nurses had no association with new infected cases ((P=0.876, coefficient =3386.30, 95% Cl=-41533.87, 48306.47). Furthermore, according to our results, the ICU beds did not associated with incidence of infection (P=0.327, coefficient =-67.82, 95% Cl=-206.37, 70.73) (Table. 3).

Table 2. Post hoc analysis on death cases by country regions and time to challenging by covid-19

Characteristic	First month completed challenging by covid-19*	Second month completed challenging by covid-19**	Current status***
Albania	0.73 ABC	-	0.57 A
Austria	1 ABC	16.67 A	8.83 AB
Belarus	0.00 A	-	1.11 A
Belgium	0.00 A	38.1 A	82.46 D
Bosnia and Herzegovina	0.57 AB	-	1.08 A
Bulgaria	0.73 ABC	-	1.13 A
Croatia	0.03 A	1.67 A	0.85 A

(Continued)

Table 2. Post hoc analysis on death cases by country regions and time to challenging by covid-19 (Continued)

Characteristic	First month completed challenging by covid-19*	Second month completed challenging by covid-19**	Current status***
Cyprus	0.3 A	-	0.3 A
Czechia	0.77 ABC	-	3.89 A
Denmark	1.73 ABC	-	6.95 AB
Estonia	0.03 A	-	0.79 A
Finland	0.17 A	-	3.01 A
France	0.03 A	28.7 A	242.16 E
Germany	0.00 A	8.9 A	64.72 BCD
Greece	0.87 ABC	-	2.2 A
Hungary	0.7 ABC	-	5.04 A
Iceland	0.07 A	-	0.18 A
Ireland	1.53 ABC	-	18.11 AB
Italy	0.97 ABC	385.4 C	305.52 F
Latvia	0.00 A	-	0.22 A
Lithuania	0.23 A	-	0.7 A
Luxembourg	0.7 ABC	-	1.52 A
Moldova	0.63 ABC	-	1.75 A
Montenegro	0.13 A	-	0.15 A
Netherlands	18.23 D	-	74.21 CD
Norway	0.47 AB	-	3.37 A
Poland	1.9 ABC	-	9.5 AB
Portugal	5.33 C	-	15.81 AB
Romania	0.77 ABC	-	9.61 AB
Russia	0.00 A	0.3 A	7.24 AB
Serbia	1.47 ABC	-	2.5 A
Slovakia	0.03 A	-	0.34 A
Slovenia	0.67 ABC	-	1.57 A
Spain	0.00 A	282.13 B	268.14 EF
Sweden	0.00 A	4.867 A	25.32 ABC
Switzerland	5.1 BC	47.867 A	26.48 ABC
Turkey	30.27 E	-	57.78 ABCD
Ukraine	0.67 ABC	-	3.79 A
United Kingdom	0.00 A	47.033 A	230.2 E

* The average of deaths from the date of the first person reported in each country up to one full month elapsed thereafter. As the letters of the alphabet progress from A to E, respectively, the situation of each country worsens in the first month of its exposure to the virus in comparison with other countries.
** The average of deaths from the date of the first person reported in each country up to two full month elapsed thereafter. As the letters of the alphabet progress from A to C, respectively, the situation of each country worsens in the second month of its exposure to the virus in comparison with other countries.
*** The average of deaths without considering the cut point for the date of the first person reported, and of course without considering the number of months or days elapsed; until the end of April 24th. As the letters of the alphabet progress from A to F, respectively, the situation of each country worsens in comparison with other countries.

Table 3. Analysis of some therapeutic and epidemiological factors related to confirmed cases in European region, simple linear regression

Characteristic	Coefficient*	95% CI (lower band, upper band)	Significance**
Latitude	-1933.42	[-3398.88, -467.95]	0.011
Longitude	-638.96	[-1279.99, 2.07]	0.051
Fertility	26729.71	[-75539.52, 128998.95]	0.600
Life Expectancy(Female)	8392.92	[1521.27, 15264.58]	0.018
Life Expectancy(Male)	4229.36	[-52.38, 8511.10]	0.053
Total population	1.31	[0.86, 1.75]	0.000
Total population(Female)	2.44	[1.56, 3.32]	0.000
Total population(Male)	2.79	[1.88, 3.71]	0.000
Migration	69.07	[41.42, 96.72]	0.000
Median age	3020.95	[-3180.93, 9222.83]	0.330
Child dependency ratio	110431.79	[-494640.80, 715504.38]	0.714
Potential support ratio	-4244.50	[-25435.44, 16946.44]	0.687
All cancer incidence	0.27	[.21, .33]	0.000
lung incidence	2.34	[1.72, 2.96]	0.000
All cancer death	0.52	[0.36, 0.68]	0.000
Lung death	2.77	[1.97, 3.56]	0.000
Hospital beds	-4146.81	[-21033.62, 12740.00]	0.617
Hospitals	613.48	[-2628.41, 3855.37]	0.699
ICU beds	-67.82	[-206.37, 70.73]	0.327
Medical doctors	3386.30	[-41533.87, 48306.47]	0.876
Nurses	-2863.94	[-10342.69, 4614.80]	0.432
Quality of life index	43.00	[-868.85, 954.84]	0.924
Safety index	-2830.80	[-5241.69, -419.90]	0.023
Health care index	2620.96	[501.66, 4740.25]	0.017
Cost of living index	277.03	[-760.99, 1315.05]	0.590

* Estimation of linear regression slope in relation to number of confirmed cases; A negative value indicates the negative impact of the desired factor
** A significance level of 5% was considered in simple regression analysis

Approximately, similar characters were related to death cases. these characteristics include life expectancy (female) (P=0.005, coefficient =1134.42, 95% Cl=355.92, 1912.92), life expectancy(male) (P=0.017, coefficient =598.29, 95% Cl=111.73, 1084.85), total population (P=0.002, coefficient =0.1, 95% Cl=0.04, 0.17), all cancer incidence (P<0.001, coefficient =0.02, 95% Cl=.01, .04), lung incidence (P=0.001, coefficient =0.19, 95% Cl=0.08, 0.30), all cancer death (P=0.004, coefficient =0.04, 95% Cl=0.01, 0.07), lung death, (P=0.002, coefficient =0.23, 95% Cl=0.09, 0.37), health care index (P=0.02, coefficient =300.54, 95% Cl=50.06, 551.02) (Table. 4).

In current study, hierarchical cluster analysis was performed using different linkages and in several measurements on European countries, and according to the interpretation of the outputs, the average linkage was selected and illustrated by dendrogram of figure 1, as well as were divided into 5 dissimilar clusters. More than 30 countries were categorized in first cluster. France, Germany, and United Kingdom were categorized in second cluster. Italy and Spain belonged to third cluster. Forth cluster only included Russia. And, turkey was in fifth cluster (Figure. 2).

Discussion

Hierarchical cluster analysis has been proposed as a statistical tool accompained by a wide range of options as well as a practical method for identifying substantial clusters in relatively homogeneous samples. Although the average linkage is supposed to represent a natural compromise between single linkage and complete linkage, researchers point out that there is no best choice, as it is often difficult to determine the optimal number of clusters in a data set. This decision depends on visual and numerical insight into the output of the figures and it could be somewhat subjective (19). On January 24, 2020, the first case of COVID-19 was confirmed in

Table 4. Analysis of some therapeutic and epidemiological factors related to deaths in European region, simple linear regression

Characteristic	Coefficient*	95% CI (lower band, upper band)	Significance**
Latitude	-273.76	[-436.70, -110.82]	0.002
Longitude	-112.57	[-181.86, -43.27]	0.002
Fertility	-37.12	[-12011.72, 11937.47]	0.995
Life Expectancy(Female)	1134.42	[355.92, 1912.92]	0.005
Life Expectancy(Male)	598.29	[111.73, 1084.85]	0.017
Total population	0.10	[0.04, 0.17]	0.002
Total population(Female)	0.19	[0.07, 0.32]	0.003
Total population(Male)	0.22	[0.09, 0.36]	0.002
Migration	4.47	[0.55, 8.39]	0.027
Median age	537.35	[-173.36, 1248.05]	0.134
Child dependency ratio	-1880.64	[-72588.55, 68827.26]	0.957
Potential support ratio	-1639.01	[-4055.47, 777.45]	0.178
All cancer incidence	0.02	[.01, .04]	0.000
lung incidence	0.19	[0.08, 0.30]	0.001
All cancer death	0.04	[0.01, 0.07]	0.004
Lung death	0.23	[0.09, 0.37]	0.002
Hospital beds	-831.00	[-2812.93, 1150.93]	0.395
Hospitals	55.92	[-329.74, 441.58]	0.766
ICU beds	-12.14	[-28.03, 3.76]	0.130
Medical doctors	770.71	[-4403.40, 5944.82]	0.757
Nurses	-321.30	[-1186.91, 544.32]	0.446
Quality of life index	16.43	[-90.67, 123.53]	0.757
Safety index	-348.81	[-629.89, -67.74]	0.017
Health care index	300.54	[50.06, 551.02]	0.020
Cost of living index	56.34	[-64.62, 177.30]	0.350

* Estimation of linear regression slope in relation to number of deaths; A negative value indicates the negative impact of the desired factor

** A significance level of 5% was considered in simple regression analysis

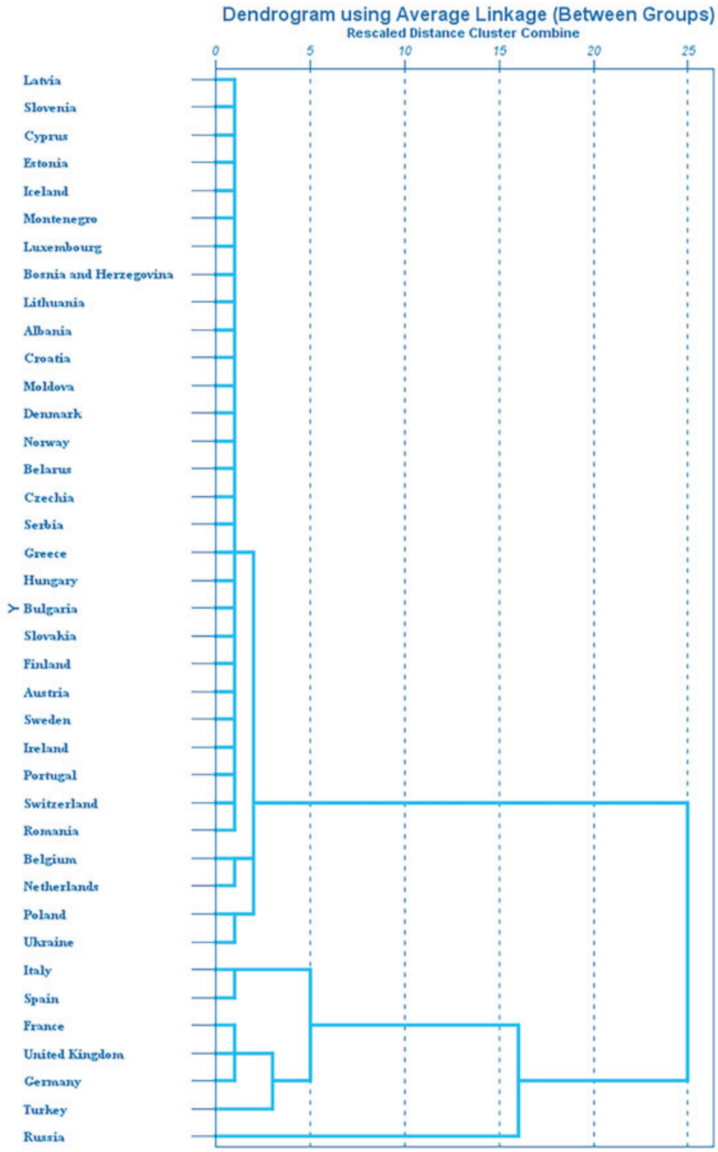

Figure 1. Dendrogram using average linkage and squared eulicidean distance method in Europian regions

France (20). However, the geographic distribution of these cases was different between European countries. Furthermore, these numbers changed during the time in each country (20). In this study, the population characters, including life expectancy, total population, and migration had a significant role in COVID-19 occurrence. We evaluated the infection severity level among all the European countries in the first and second months of infection onset and the current status until April 24, 2020. The cases of COVID-19 were categorized into mild and severe forms according to the severity level. Many countries experienced the same severity level during these three times. However, other countries showed a fluctuating pattern at these times. France had an appropriate situation in the first month, but then, the rate of infection increased, causing the cases of COVID-19 to be categorized into the severe form. This pattern was repeated in the mortality data, where the number of deaths increased rapidly. A similar pattern was also observed in Germany.

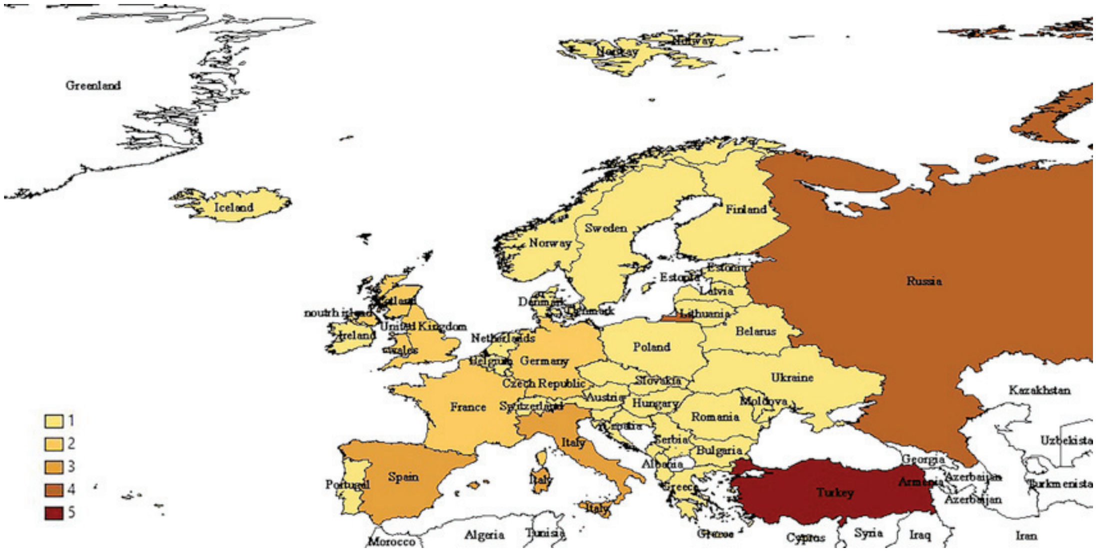

Figure 2. European plot using by independent factors associated with covid-19, a cluster analysis

Although, they first reported to have a slow ascending speed regarding the infection incidence, they then had a high number of infected cases who were categorized into the E form. Furthermore, although they reported no mortality in the first month, the number of deceased cases became significant later on. In contrast, Italy reported a high rate of infected cases at the beginning, which, subsequently, rapidly increased. In addition, the number of deceased cases also increased in this country. Currently, this country has the worst mortality rate. Similarly, Spain and UK had ascending infection patterns, and the number of COVID-19 deaths is currently higher in them compared to other countries, based on their population. In current study, finally the countries were categorized in fifth clusters according to its similar data. Most of the countries belonged to first cluster with the best situation, in terms of the number of death and confirmed cases. However, UK, Spain, Germany, and France categorized in cluster two. At last, the Russia and turkey had the worst situation and were categorized in 4th and 5th cluster. These categorization as clusters could provide the blink and quick access to evaluate and compare the degree of involvement among the regions. COVID-19 is a droplet respiratory infection that is directly affected with population density. Prevention strategies, including social distance, school and university closure, and remote working at home, could decrease the rate of this disease (21).

Based on the current study, another factor affecting COVID-19 incidence and death cases was migrant population. Migration has been considered as an important issue in Europe in recent years. Social distance is the current best solution for prevention against COVID-19. However, it appears to be impossible to observe social distance in the migrant population, especially those living in camps with suboptimal facilities. The best presented course of actions includes considering the migrant population according to their healthcare policy against COVID-19, providing them with the disseminating information in several languages, granting them the access to healthcare systems without the fear of deportation, and checking symptoms in the high-risk population frequently (22).

Another important factor was the presence of cancer, especially lung cancer. Fever and cough are the most common symptoms of this infection. Fever is one of the indications of diagnosis tests, including CT-scan and PCR. Cough is usual in COVID-19 cases, and is more common in lung cancer patients. However, the diagnosis of SARS-CoV-2 is difficult in lung cancer patients based on the clinical symptoms of COVID-19. According to previous studies, the lethality of SARS-CoV-2 increased about 5.6% in the presence of co-morbidities. In addition, previous experiences about influenza virus infection showed that a specific malignancy treatment with immunocompromised potency could raise the risk of infection and mortality (23). COVID-19 is rapidly presented as a severe form of infection in cancerous patients (24). The prevalence of severe cases was five times more among cancerous patients than among the normal population (24). According to previous studies, lung cancer patients have more risk factors for the aggressive presentation of COVID-19 (24). Risk factors due to lung cancer could increase the risk of COVID-19 and its severe presentation (24). These risk factors include old age, smoking, low immunity, and malnutrition (24). Moreover, lung cancer could lead to more complications of COVID-19. It appears that chemotherapy could worsen the outcome of these patients. It is suggested to postpone all regimens in COVID-19 cases to the extent possible. Lung cancer cases with family members diagnosed as COVID-19 should be tested in short intervals during the malignancy treatment, even if they are asymptomatic (25). However, postponing treatments depends on physicians' decisions. Therefore, physicians should estimate and compare the risk of postponing treatments against COVID-19 infection (26). Overall, current study provides an easy access to compare different countries of region in terms of incidence and prevalence of Covid-19. Furthermore, it appears it could be a simple and available access to inform the weak and power points of public health policy among these countries in control the pandemic. The current study revealed different distribution patterns of confirmed COVID-19 cases and mortality among the European countries. However, this study has limitations, too. Unfortunately, in some characters, we did not access to registry data of all European countries, including Hospital facilities, all types of cancers or migration data. Future updated epidemiologic investigations are recommended.

Conclusion

Overall, current study revealed, different distribution of confirmed cases and mortality among European countries. And, it appears that several factors are associated with the different distribution patterns among the regions, including total population, life expectancy, migration, geographical longitude, prevalence of all types of cancer, and the health care index.

Acknowledgments: This study was performed in Gastroenterology and Liver Diseases Research Centre of Shahid Beheshti University of Medical Sciences and supported by grant number 23756

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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Received: 25 June 2020
Accepted: 3 August 2020
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