

Title: A normalized mortality rate showed the diverse severity of Covid-19 and its association
with other chronic diseases

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Abstract

Covid-19 has given a halt to all the activities in the world. Europe was most affected followed by the United States of America. It has taken more than 200,000 lives till now. In this study, we have assessed the severity of Covid-19 by analyzing the mortality rate in Covid-19 and other diseases to see the severity of Covid-19 and other chronic diseases. The Covid-19 data and “death rate” data caused by other diseases were downloaded from the world health organization (WHO) website. A normalized period based method was used to see the mortality rate of Covid-19 in comparison to other diseases. The deaths occurred by cardiovascular diseases, cancer, and respiratory diseases were more in number than the Covid-19 caused deaths in the 45 days period where most of the Covid-19 deaths had taken place. The severity of Covid-19 in the USA was moderate. The severity of Covid-19 in Asian countries was found to be at a low. Europe showed the highest diversity in the mortality rate of Covid-19. Cardiovascular diseases, cancer, and non-communicable diseases were still more lethal and caused more deaths than Covid-19.

Keywords: Covid-19, SARS-Cov-2, Mortality rate, Cancer, Cardiovascular disease, Respiratory disease, Diabetes, Kidney diseases

Introduction

Covid-19 has crossed a three million mark causing more than 211000 deaths worldwide in just over three months[1]. It was started in China and spread all over the world[2,3]. Europe and the United States of America (USA) were the worst affected by SARS-Cov-2 infection. Italy, Spain, France, and the United Kingdom (UK) together and the USA alone have lost more than 90,000 and 45,000 lives in less than two months. It was on increase in Europe and the USA as well as in other parts of the world. It is on increase in Europe and the United States of America.

Fever, cough, and shortness of breath were found to be the initial symptoms in SARS-Cov-2 infection[4]. Most of the countries have been under lockdown to stop the transmission of SARS-Cov-2. It is not completely known how Covid-19 was associated with other pre-existing disease conditions and why the mortality rate differed in different countries and regions. It has been reported that Covid-19 mortality was increased by multifold in pre-existing Cardiovascular diseases, Cancer, Diabetes mellitus, and Kidney diseases[5,6].

We hypothesized that Covid-19 severity was diverse by country and region and not as lethal as Cardiovascular diseases, Cancer, or other chronic diseases.

In this study, we have analyzed the total death counts of Covid-19, Cardiovascular diseases, Cancer, Respiratory diseases (non-communicable), respiratory infectious diseases, Diabetes mellitus, and kidney disease in a 45 days period (13th March to 26th April 2020) where most of the Covid-19 deaths had taken place to see the severity and diversity of Covid-19 in comparison to other diseases.

Materials and Methods

There was a different opinion on the incubation period of SARS-Cov-2[7]. It was reported as 5 days to 14 days of incubation period[8,9]. In this study, the mortality rate of Covid-19 in comparison to other diseases was calculated based on 45 days period. This period could have 9 cycles of incubation period with the least incubation period or 3 cycles of incubation period at high incubation period of 14 days.

Two different datasets were used for this study. As the first dataset, Covid-19 data was downloaded from the Covid-19 dashboard set up by WHO[10]. Covid-19 data was updated till 26th April 2020. Deaths caused by Covid-19 was calculated for 45 days period from 13th March to 26th April 2020. As the second dataset, Global Health Estimate (GHE) 2016 summary table which was released in March 2018 by Department of information, Evidence, and Research, World Health Organization (WHO), Geneva, Switzerland was downloaded from the WHO website[11]. GHE code – 0, 380, 610, 800, 1100, 1170, and 1270 which contain data for all causes, Respiratory infectious diseases, Malignant neoplasms, Diabetes mellitus, Cardiovascular diseases, Non-communicable respiratory diseases, and Kidney diseases respectively were used for this study.

The mortality rate of Covid-19 was calculated by two methods. As the first method mortality rate was calculated by dividing the total deaths caused by Covid-19 by the total number of positive Covid-19 cases per 1000. This method was used to see the death rate of Covid-19 among positive Covid-19 people. The second method was based on the total number of deaths caused by Covid-19 and other diseases in 45 days period to compare the severity of Covid-19 with other diseases. The mortality rate caused by different diseases and reasons were converted into deaths per one and half month (45 days). The downloaded data was in the unit of mortality per 1,00,000 population. The given mortality rate was divided by 1,00,000 and then multiplied by the

population of that country which gave the number of deaths by various causes per year. It further divided by 8, which gave an average death occurred per one and a half months for the respective country. Covid-19 caused deaths for the period of 45 days (13th March – 26th April 2020) was compared with the deaths caused by Cardiovascular diseases, Cancer, Non-communicable respiratory diseases, Respiratory infectious diseases, Diabetes mellitus, and Kidney diseases in 45 days period. All the countries who have reported more than 100 deaths by Covid-19 were included at the preliminary label. Only those countries were included for the final study where high completeness and quality of cause of death assignment was available (according to WHO norms)[12]. All the calculations performed, and graphs were drawn in R version 3.6.2 and Microsoft Excel[13,14].

Results

France showed the highest mortality rate (Covid-19 caused deaths out of Covid-19 positive cases per 1000) at 184 which was followed by Belgium, UK, and Italy 153, 137, and 135 respectively (Figure1). The mortality rate in Brazil, Canada, and the USA was at 69, 53, and 51 respectively (Figure1). Japan, Norway, the Republic of Korea, Chile, and Israel were at the bottom place with a mortality rate at 26, 26, 23, 14, and 13 respectively (Figure1).

Italy, France, Spain, UK, and Belgium lost 25368, 22532, 22440, 20311, and 6917 lives respectively in 45 days period because of Covid-19. The mortality rate was found highest in Belgium followed by Spain, France, and Italy at 50, 42.9, 32.3, and 31.7 percent respectively of the number of deaths taken place from all causes in a 45 days period on average (Figure 2). These countries were not only on top in Europe but in the world. They were considered as a high risk group for Covid-19. There was another group of countries that showed a moderate percentage of deaths caused by Covid-19 in comparison to total deaths that occurred by all causes in a 45 days

period. Switzerland and the USA with 15.8 and 13.2 percent of mortality share led this group (Figure 3). The third and the lowest risk group was led by Norway while Japan was found at the bottom with 3.8 and 0.2 percent mortality share in total deaths by all causes (Figure 4).

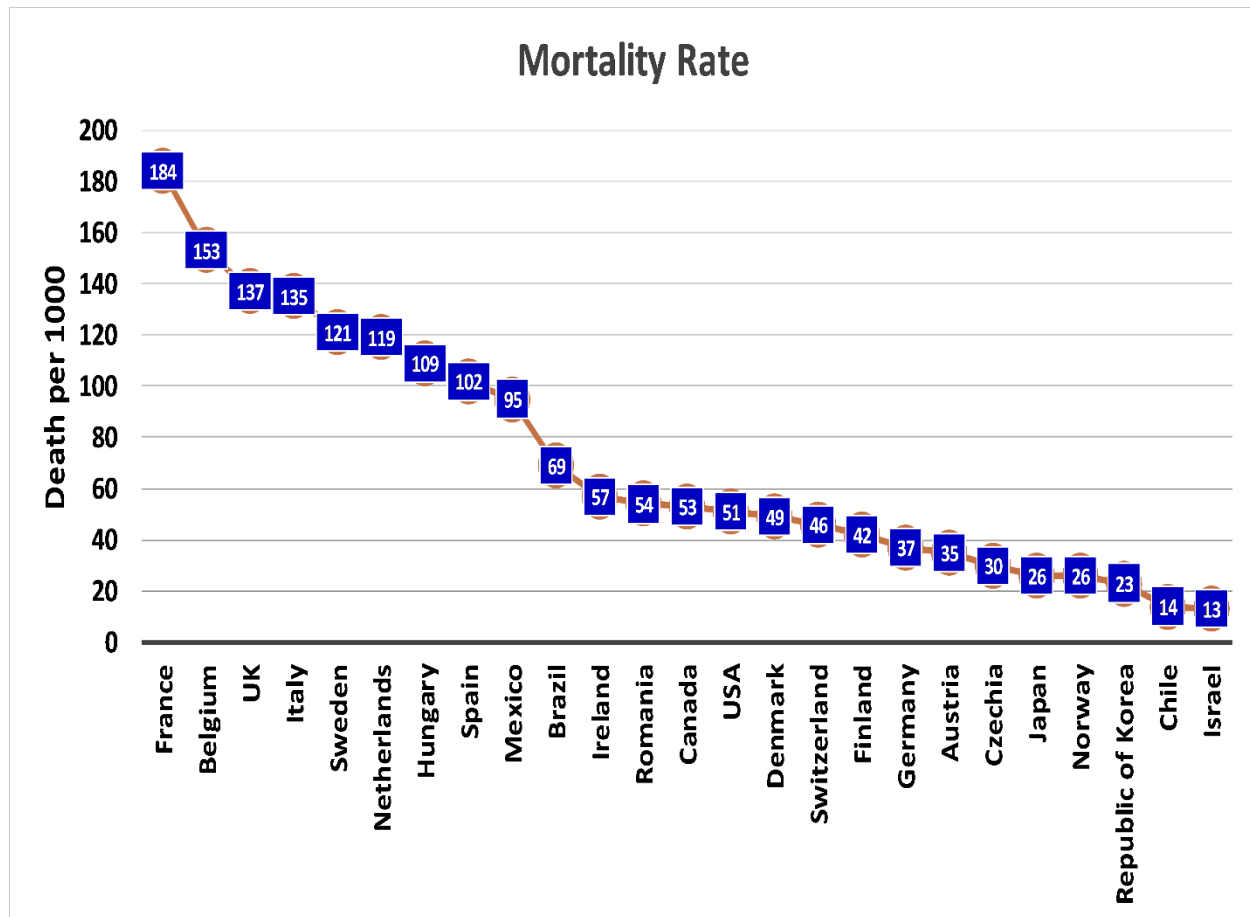


Figure1: Mortality Rate of Covid-19

Mortality rate of Covid-19 was calculated as deaths caused by Covid-19 per 1000 Covid-19 affected people; UK: The United Kingdom; USA: The United States of America

Deaths recorded under Covid-19 overtook Cancer and Cardiovascular diseases caused deaths in Belgium, Spain, and France (Figure2). In Italy, Covid-19 caused deaths were below the cardiovascular diseases caused deaths, but more than cancer caused deaths (Figure2). In the UK, that Covid-19 caused deaths were below cancer caused deaths, but more than the cardiovascular diseases caused deaths (Figure2).

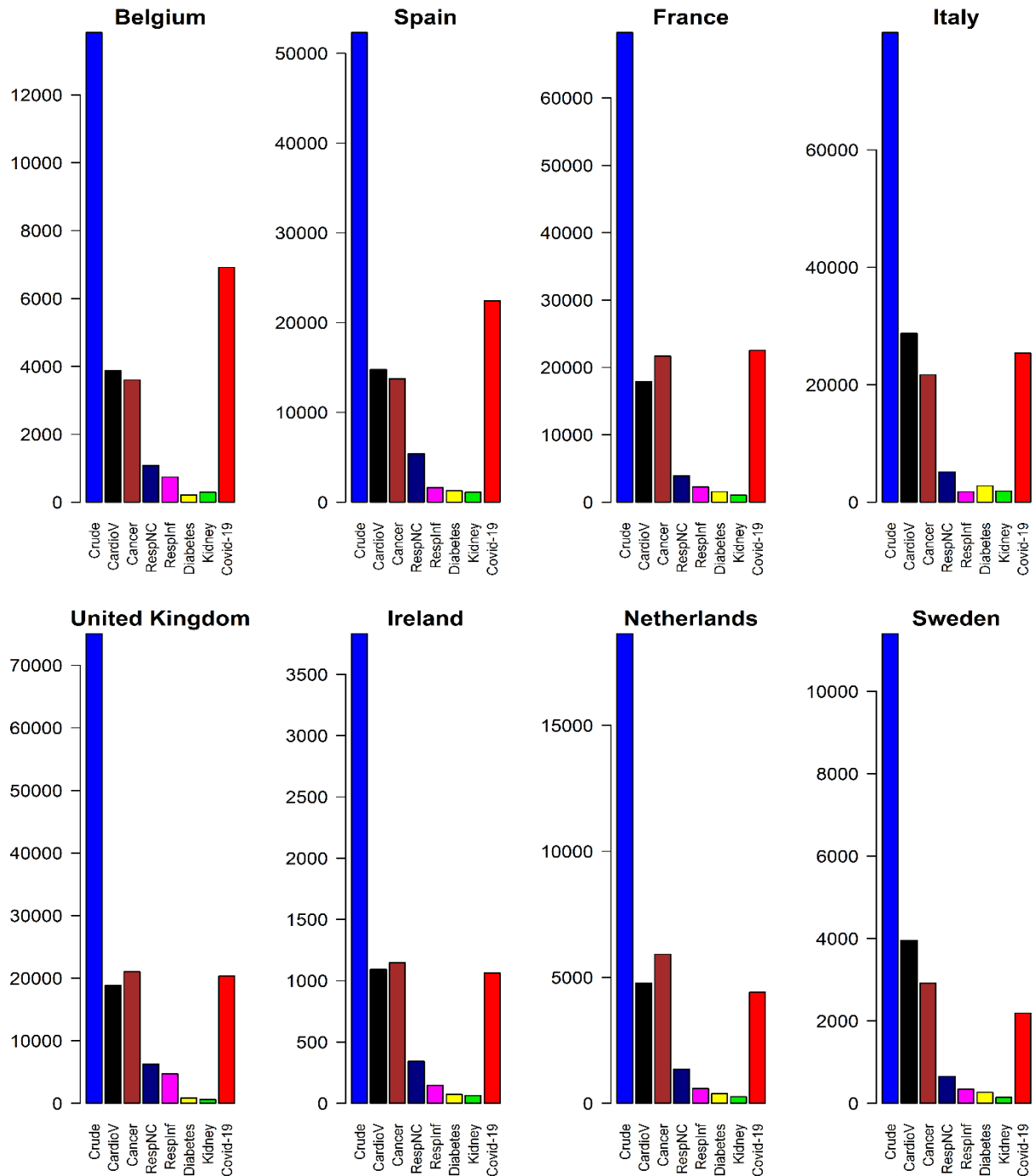


Figure-2: Deaths Caused by Covid-19 and Other Diseases (High risk group)

X-axis denotes the causes of death; Y-axis denotes the number of deaths in a 45 days period; Crude: Total deaths occurred by all causes; CardioV: Deaths caused by Cardiovascular diseases; Cancer: Deaths caused by Cancer; RespNC: Deaths caused by non-communicable Respiratory diseases; RespInf: Deaths caused by Respiratory infectious diseases; Diabetes: Deaths caused by Diabetes mellitus; Kidney: Deaths caused by Kidney diseases; Covid-19: Deaths caused by Covid-19

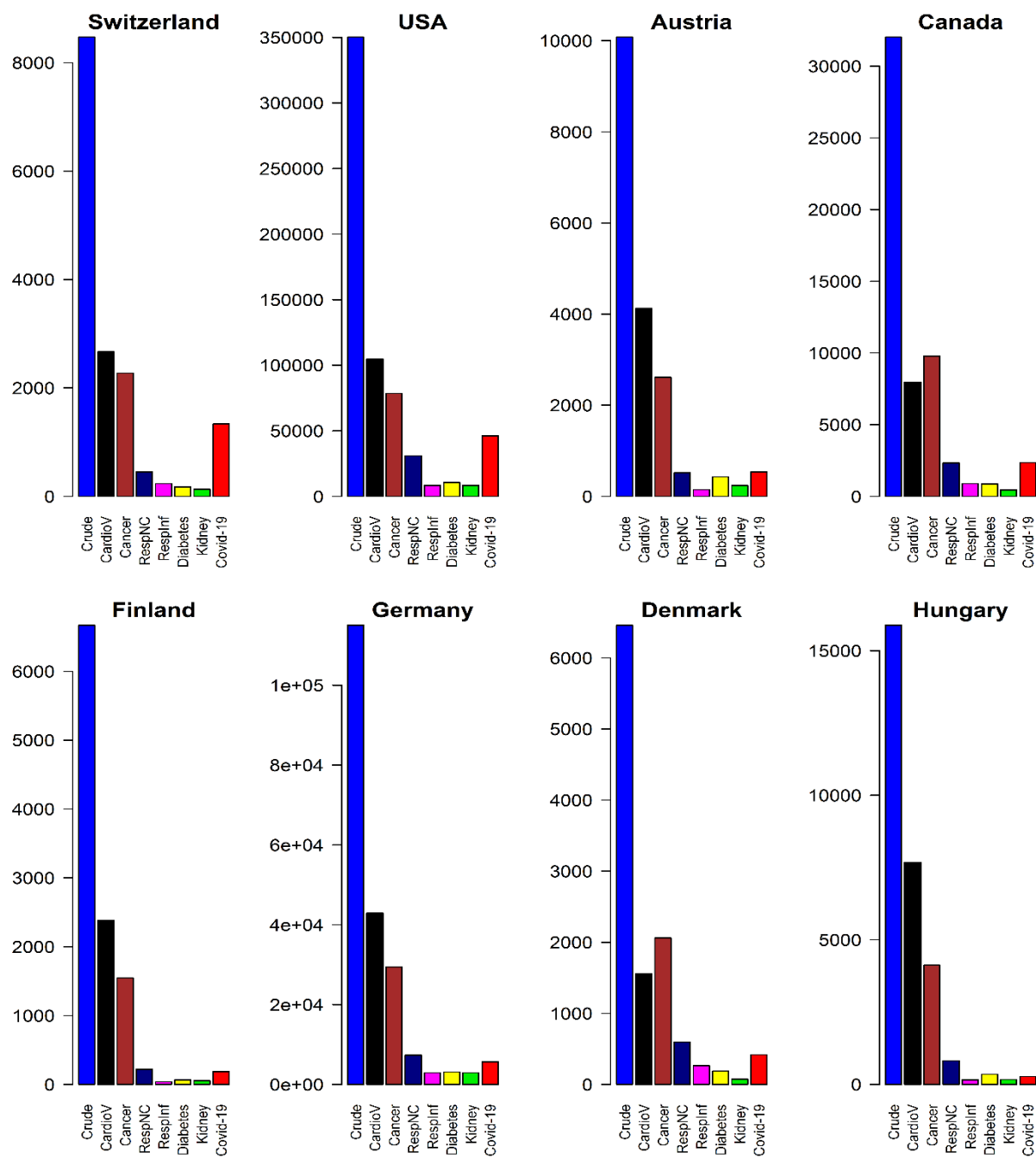


Figure-3: Deaths Caused by Covid-19 and Other Diseases (Moderate risk group)

X-axis denotes the causes of death; Y-axis denotes the number of deaths in a 45 days period; Crude: Total deaths occurred by all causes; CardioV: Deaths caused by Cardiovascular diseases; Cancer: Deaths caused by Cancer; RespNC: Deaths caused by non-communicable Respiratory diseases; RespInf: Deaths caused by Respiratory infectious diseases; Diabetes: Deaths caused by Diabetes mellitus; Kidney: Deaths caused by Kidney diseases; Covid-19: Deaths caused by Covid-19; USA: The United States of America

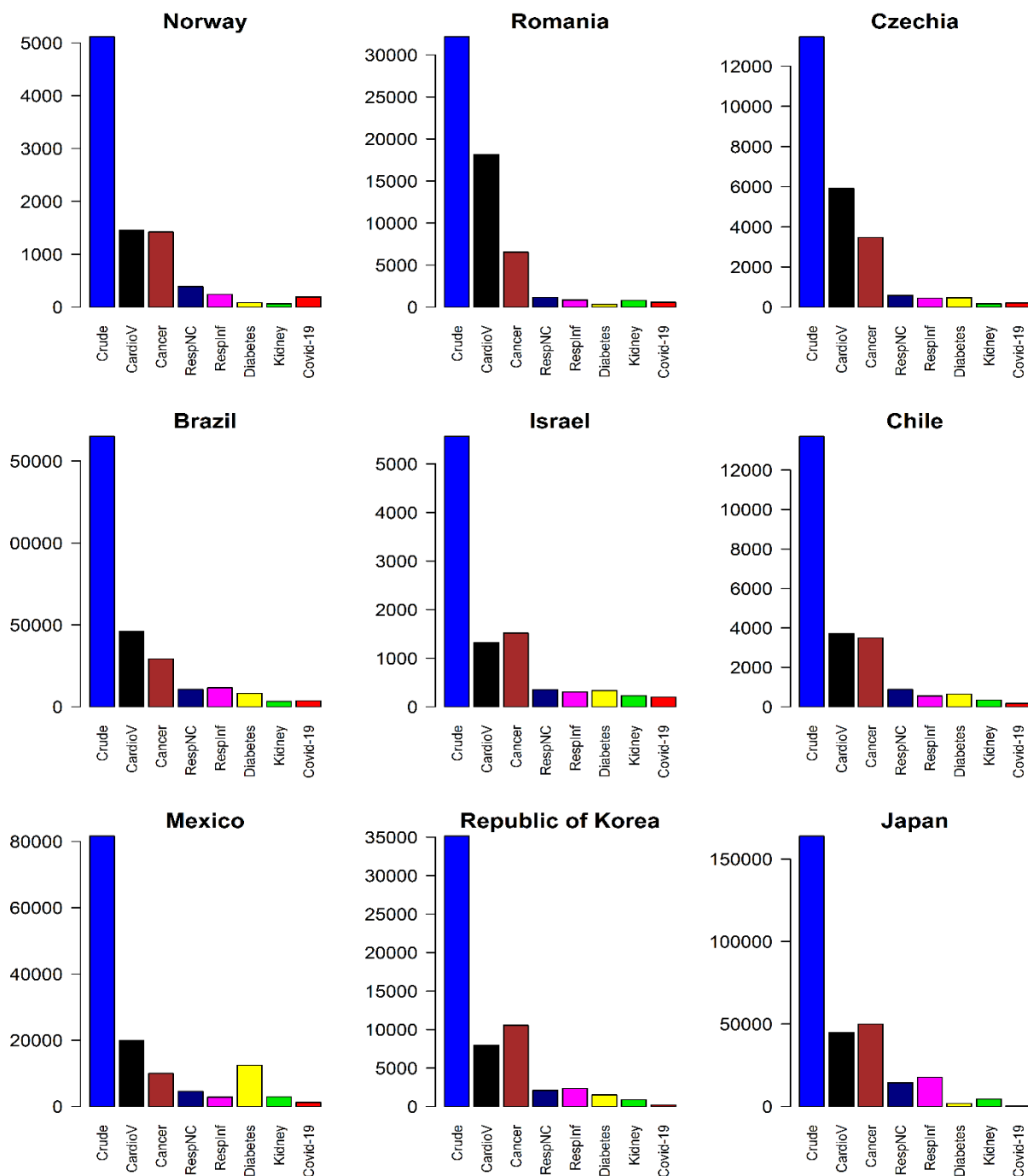


Figure-4: Deaths Caused by Covid-19 and Other Diseases (Low risk group)

X-axis denotes the causes of death; Y-axis denotes the number of deaths in a 45 days period; Crude: Total deaths occurred by all causes; CardioV: Deaths caused by Cardiovascular diseases; Cancer: Deaths caused by Cancer; RespNC: Deaths caused by non-communicable Respiratory diseases; RespInf: Deaths caused by Respiratory infectious diseases; Diabetes: Deaths caused by Diabetes mellitus; Kidney: Deaths caused by Kidney diseases; Covid-19: Deaths caused by Covid-19

The deaths caused by Covid-19 in Switzerland, the USA, Austria, Canada, Finland, Germany, Denmark, and Hungary were below cancer and cardiovascular diseases caused deaths but higher than the respiratory infectious diseases, diabetes, and kidney diseases except for Hungary, where Diabetes caused deaths was more than the Covid-19 caused deaths in the study period(Figure3). The Covid-19 caused deaths in Switzerland, the USA, Canada, and Austria were found to be lower than the Cancer and Cardiovascular diseases but higher than all other diseases included in the study(Figure3). The deaths caused by Covid-19 in Israel, Mexico, Chile, the Republic of Korea, and Japan were least in comparison to cardiovascular diseases, cancer, non-communicable respiratory diseases, communicable infectious diseases, diabetes mellitus, and kidney diseases (Figure4). The mortality rate of Covid-19 in Norway was higher than the diabetes mellitus and kidney diseases (Figure4). The mortality rate of Covid-19 in Romania was higher than the diabetes mellitus while in Brazil and Czechia it was higher than the kidney diseases (Figure4).

Discussion

The result divided the Covid-19 affected countries into three risk groups. The highest risk group was having eight countries and all of them were from Europe. The USA and Canada fell under a moderate risk group of countries with six other European countries. The third and the low - risk group contained countries were from Europe, Asia, North America, and South America.

The result showed that Covid-19 severity in terms of Covid-19 positive cases as well as in comparison to other diseases was diverse in the world. Although it started in China, China and its neighboring countries were not at high risk in comparison to the European countries. The severity of Covid-19 was also diverse within Europe. Based on Covid-19 deaths out of Covid-19 positive cases, France and Belgium were at the highest risk, Denmark, Austria, and Germany at moderate and Norway at low risk. Based on the total death rate, Belgium and Spain were at the highest risk,

Austria and Germany at moderate risk while Czechia was at low risk in terms of percent of Covid-19 caused deaths out of total deaths occurred by all causes. In both ways of mortality rate calculation, the USA and Canada were at moderate risk. Japan, Chile, and the Republic of Korea were also at low risk by each method of the mortality rate calculation. The death caused by Covid-19 in high risk group countries and Switzerland were more than the cumulative death count by Respiratory diseases non-communicable, Respiratory infectious diseases, Diabetes mellitus, and Kidney diseases.

Germany and Italy as the neighboring country showed a different spectrum of Covid-19 severity. Sweden found at high risk while Norway in the West of Sweden found at low risk and Finland to the East of Sweden at moderate risk. Further, European countries featured in each group that showed the diversity of severity of Covid-19 in Europe. Outside Europe, Covid-19 severity was in moderate to low risk zone.

latest reports on Covid-19 showed that a diseased condition or a person with cancer, cardiovascular, respiratory diseases, or other diseases were at higher risk of SARS-Cov-2 infection[15–17]. It was also reported that Covid-19 increased the severity of preexisting diseases[18–20]. Three months was very little time (since Covid-19 birth) to know a disease completely. It might be possible that Covid-19 made the pre-existing diseases more severe, but the deaths caused by these conditions were counted under Covid-19 ignoring the preexisting diseases.

Overall, Covid-19 caused deaths were not the highest in number during the 45 days period where most of the deaths had occurred worldwide but below the cardiovascular and cancer caused deaths on an average in high risk group countries except Belgium, Spain, and France and partially in Italy and the UK. Other European countries in moderate and low risk groups showed Covid-19 caused deaths as par with respiratory diseases, diabetes mellitus, and kidney diseases. The deaths

occurred by Cardiovascular diseases, Cancer, respiratory diseases, diabetes mellitus, and kidney diseases in the world were more in number than Covid-19 caused deaths during the 45 days period on an average.

A greater number of people could die by other diseases if other diseases especially Cardiovascular diseases, Cancer, Respiratory diseases, Diabetes mellitus, and Kidney diseases were ignored because of tested as Covid-19 positive[5,21–24]. It would be possible that Covid-19 was not life threatening disease as a single entity but helped pre-existing diseases to progress fast towards mortality.

Ethical approval: This study did not require any ethical approval

Conflict of interest: None

Reference

1. Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infect Dis.* 2020;3099(20):19–20. [http://dx.doi.org/10.1016/S1473-3099\(20\)30120-1](http://dx.doi.org/10.1016/S1473-3099(20)30120-1)
2. Spiteri G, Fielding J, Diercke M, Campese C, Enouf V, Gaymard A, et al. First cases of coronavirus disease 2019 (COVID-19) in the WHO European Region, 24 January to 21 February 2020. *Euro Surveill.* 2020;25(9). <https://doi.org/10.2807/1560-7917.ES.2020.25.9.2000178>
3. Andersen, K.G., Rambaut, A., Lipkin, W.I. et al. The proximal origin of SARS-CoV-2. *Nat Med* (2020). <https://doi.org/10.1038/s41591-020-0820-9>
4. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan , China : a

- descriptive study. *Lancet*.2020;395:507–13.
[http://dx.doi.org/10.1016/S0140-6736\(20\)30211-7](http://dx.doi.org/10.1016/S0140-6736(20)30211-7)
5. Chen J, Qi T, Liu L, Ling Y, Qian Z, Li T, et al. Clinical progression of patients with COVID-19 in Shanghai, China. *J Infect*. 2020;80:e1–6.
<https://doi.org/10.1016/j.jinf.2020.03.004>
 6. W.-J. G, W.-H. L, Y. Z, H.-R. L, Z.-S. C, Y.-M. L, et al. Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. *Eur Respir J*. 2020; 2000547 <http://dx.doi.org/10.1183/13993003.00547-2020>
 7. Jiang X, Rayner S, Luo MH. Does SARS-CoV-2 has a longer incubation period than SARS and MERS? *J Med Virol*. 2020;92:476–78. <http://doi.org/10.1002/jmv.25708>
 8. Linton NM, Kobayashi T, Yang Y, Hayashi K, Akhmetzhanov AR, Jung S, et al. Incubation Period and Other Epidemiological Characteristics of 2019 Novel Coronavirus Infections with Right Truncation: A Statistical Analysis of Publicly Available Case Data. *J Clin Med*. 2020;9(2):538. <https://doi.org/10.3390/jcm9020538>
 9. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR, et al. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. *Ann Intern Med*. 2020;2019. <https://doi.org/10.7326/M20-0504>
 10. <https://covid19.who.int/>
 11. Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. Geneva, World Health Organization; 2018.
http://www.who.int/healthinfo/global_burden_disease/estimates/en/

12. WHO methods and data sources for global causes of death 2000-2016. Global Health Estimates Technical Paper WHO/HIS/IER/GHE/2018.3. Geneva: World Health Organization; 2018
http://www.who.int/healthinfo/global_burden_disease/GlobalCOD_method_2000_2016
13. R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.
14. Microsoft Corporation. Microsoft Excel for Office 365. URL: <https://office.microsoft.com/excel>
15. Shi S, Qin M, Shen B, et al. Association of Cardiac Injury With Mortality in Hospitalized Patients With COVID-19 in Wuhan, China. *JAMA Cardiol.*2020. <https://doi.org/10.1001/jamacardio.2020.0950>
16. Landman A, Feetham L, Stuckey D. Cancer patients in SARS-CoV-2 infection : a nationwide analysis in China. 2020;2045:335–37.
[https://do.org/10.1016/S1470-2045\(20\)30096-6](https://do.org/10.1016/S1470-2045(20)30096-6).
17. Cheng Y, Luo R, Wang K, Zhang M, Wang Z, Dong L, et al. Kidney disease is associated with in-hospital death of patients with COVID-19. *Kidney Int.* 2020;1–10.
<https://doi.org/10.1016/j.kint.2020.03.005>
18. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan , China : a retrospective cohort study. *Lancet.* 2020;395(10229):1054-1062. [https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3)
19. Diao B, Feng Z, Wang C, Wang H, Liu L, Wang C, et al. Human Kidney is a Target for Novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection.

- medRxiv 2020.03.04.20031120v4; <https://doi.org/10.1101/2020.03.04.20031120>
20. Tan, L., Wang, Q., Zhang, D. et al. Lymphopenia predicts disease severity of COVID-19: a descriptive and predictive study. *Sig Transduct Target Ther* 5, 33 (2020).
<https://doi.org/10.1038/s41392-020-0148-4>
 21. Zheng YY, Ma YT, Zhang JY, Xie X. COVID-19 and the cardiovascular system. *Nat Rev Cardiol.* 2020;17. <http://dx.doi.org/10.1038/s41569-020-0360-5>
 22. Guo W, Li M, Dong Y, Zhou H, Zhang Z, Tian C, et al. Diabetes is a risk factor for the progression and prognosis of COVID-19. *Diabetes Metab Res Rev.* 2020;1–9.
<http://doi.org/10.1002/dmrr.3319>
 23. Li Z, Wu M, Yao J, Guo J, Liao X, Song S, et al. Caution on Kidney Dysfunctions of COVID-19 Patients. *SSRN Electron J.* 2020;1–25.
<http://dx.doi.org/10.2139/ssrn.3559601>
 24. Hussain A, Bhowmik B, do Vale Moreira NC. COVID-19 and diabetes: Knowledge in progress. *Diabetes Res Clin Pract.* 2020;162:108142.
<https://doi.org/10.1016/j.diabres.2020.108142>